SCIENCE ABSTRACTS.

Section A.—PHYSICS.

OCTOBER 1916.

CONTENTS.

GENERAL PHYSICS.

PAGE
1097. Representation of a Damped Harmonic Function. *A. Guillet* 417
1098. Surface-tension Effects in Metals. *F. C. Thompson* 417
1099. Brownian Movement of Particles of Oil in Gases. *A. Schidlof & A. Targonski* 417
1100. Discharge of Gases through Nozzles. *Rayleigh* 418
1101. Reflection of Molecules and Mechanism of Adsorption. *I. Langmuir* 418
1102. Waves of Elementary Oscillation Form. *K. Uller* 420
1103. Gravitation and Temperature. *E. H. Barton* 420
1104. Laws of Skin Friction. *C. H. Lees* 421
1105. Note on Echelon Waves. *G. Greenhill* 421
1106. An Experimental Tank reproducing Wave Motion. *G. Russo* 421
1107. Haloes at Fort Worth and Occurrence of Precipitation. *H. H. Martin* ... 422
1108. Horizontal Rainbows on Lake Mendota. *C. Juday* 422
1109. Temperature of the Ocean on West Coast of America. *A. H. Clark* 422
1110. Photographic Determination of Latitude. *S. Hirayama* 423
1111. Surface Currents of Jupiter during 1915–1916. *S. Bolton* 423
1112. Irregular Variable R.S. Camelopardalis. *C. Martin & H. C. Plummer* ... 423
1113. Observations of V Cassiopeiæ. *A. N. Brown* 423
1114. Observations of Double Star, Krueger 60. *E. E. Barnard* 424
1115. Galaxy of B Stars. *C. V. L. Charlier* 424
1116. Law of Distribution in Star Clusters. *J. H. Jeans* 424
1117. Theory of Star-streaming. *J. H. Jeans* 424
1118. Aurora Borealis Observations in 1913. *C. Störmer* 424

LIGHT.

PAGE
1119. Doubly Refractive Sol of Vanadium Pentoxide. *H. R. Kruyt* 425
1120. Pressure of Light by Metal-foil. *G. D. West*........................ 425
1121. Mechanical Equivalent of Light. *H. E. Ives & E. F. Kingsbury*........ ... 426
1122. Platinum Standard of Light. *H. E. Ives*.......................... 426
1123. Cold Light. *Dussaud* 427
1124. Heterochromatic Brightness Discrimination Threshold. *L. T. Troland*... 427
1125. Image Formation by Crystalline Media. *H. F. Dawes* 427
1126.. 427
1127. New Modification of Ionisation Method of Measuring X-rays. *H. E. Donnithorne*.. 427
1128. Passage of X-rays through Narrow Apertures. *E. G. Taylor* 428
1129. X-ray Spectra of the Elements Na to Cr. *M. Siegbahn & W. Stenström*... 428
1130. Interference of X-rays employing Amorphous Substances. *P. Debye & P. Sherrer* 428
1131. Extraction of Radium from Carnotite. *C. L. Parsons, R. B. Moore, S. C. Lind, & O. C. Schaefer* 429
1132.. 429

HEAT.

1133. Specific Heat of Solid Nitrogen. *W. H. Keesom & H. K. Onnes*............ 430
1134. Generic Entropy and Gaseous Mixtures. *E. Guillaume*..................... 430
1135. Press for Studying Melting-points. *E. Jänecke*........................... 430
1136. Melting-points of Gypsum, Soda, Borax, etc. *E. Jänecke* 431
1137. On the Kinetic Theory of Evaporation. *A. March* 431
1138. Electrodynamic Interpretation of Planck's Constant "*h*." *A. L. Bernouilli*... 431
1139. Criteria for Grey Radiation. *P. G. Nutting* 432
1140. A Method of deriving Planck's Law of Radiation. *G. Green*.................. 432

SOUND.

1141. Energy acquired by Resonators from Incident Waves. *Rayleigh*........... 433
1142. Piano with Electrically-sustained Notes 433
1143–1145.. 433

ELECTRICITY AND MAGNETISM.

1146. Mutual Magnetic Energy of Two Moving-point Charges. *A. Anderson*... 434
1147. Small Discharges in Dark Photoelectric Cells. *J. Elster & H. Geitel*..... 434
1148. Molecular Electrostatic Field in Compressed Gases. *C. E. Guye*........... 435
1149. Possibility of Three Varieties of Explosive Potential. *C. E. Guye* 435
1150. Effect of Temperature on Light-sensitiveness of Selenium. *E. O. Dieterich* 436
1151. Temperature Coefficient of Contact Potential. *F. Sanford*.................. 436
1152. Thermoelectric Relations in Iron Oxide. *C. C. Bidwell*.................... 436
1153. Cause of Lowered Dielectric Strength in H.F. Fields. *W. M. Thornton* 436
1154. Experiments with Mercury-jet Interrupters. *C. E. S. Phillips*............. 437

PAGE
1155. Protected Thermo-elements. *A. W. Gray* 437
1156. Constant-high-potential Apparatus. *K. Fuji & S. Nishikawa* 437
1157. Resistivities and Thermal E.M.F.'s of Ca, Al, and Mg. *E. F. Northrup* ... 438
1158. Dynamic Transformer for Alternating Currents. *A. G. Rossi* 438
1159. Paramagnetism of Palladium with Absorbed Hydrogen. *H. F. Biggs* ... 438
1160. Sunspots and Daily Range of Magnetic Declination. *A. L. Cortie* 439
1161. Transformations of Special Steels. *K. Honda, K. Tawara, & H. Takagi* 439
1162. Technique of the Coolidge Tube. *A. Teillard* 440
1163. Electro-vibrators with Small Currents. *J. Bergonié* 440

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1164. Sorption of Uranium X_1 by Charcoal. *H. Freundlich & H. Kaempfer* ... 441
1165. Viscosity of Liquefied Gases. Liquid Oxygen-Nitrogen Mixtures. *J. E. Verschaffelt & C. Nicaise* 441
1166. Isotopes of the Chemical Elements. *A. van den Broek* 442
1167. Position of Martensite in the Iron-Carbon Diagram. *W. Broniewski* 442
1168. The Theory of the Corrosion of Steel. *L. Aitchison* 442
1169. Comparison between Electrolytic and Lake Copper. *C. H. Mathewson, E. M. Thalheimer* 443
1170. Copper-Cerium Alloys and their Constitution. *F. Hanaman* 444
1171. Binary Alloys of Aluminium. *H. Schirmeister* 444
1172. Ebullioscopic Behaviour of Solvents. *E. Beckmaun & O. Liesche* 444
1173. Transition-points of Nitrates (Silver, Ammonium). *E. Jänecke* 445
1174. Transition of the Metals Tin, Zinc, and Antimony. *E. Jänecke* 445
1175. Condition of Dissolved Electrolytes. *H. C. S. Snethlage* 445
1176. New Form of Dilution Law of Electrolytes. *G. v. Georgievics* 447
1177. 448
1178. Electrostatic Measurements of Electrode Potentials. *G. Borelius* 448
1179. Electro-analytical Method for Estimation of Metals of Copper-Tin Group. *E. P. Schoch & D. J. Brown* 448

AUTHORS' INDEX.

Aitchison, L., 1168.
Anderson, A., 1146.
Barnard, E. E., 1114.
Barton, E. H., 1103.
Beckmann, E., 1172.
Bergonié, J., 1163.
Bernoulli, A. L., 1138.
Bidwell, C. C., 1152.
Biggs, H. F., 1159.
Bolton, S., 1111.
Borelius, G., 1178.
van den Broek, A., 1166.
Broniewski, W., 1167.
Brown, A. N., 1113.
Brown, D. J., 1179.
Charlier, C. V. L., 1115.
Clark, A. H., 1109.
Colson, A., 1177.
Cortie, A. L., 1160.
Dawes, H. F., 1125.
Debye, P., 1130.
Dieterich, E. O., 1150.
Donnithorne, H. E., 1127.
Dussaud, 1123.
Elster, J., 1147.
Epstein, P. S., 1132.
Freundlich, H., 1164.
Fuji, K., 1156.
Geitel, H., 1147.
v. Georgievics, G., 1176.
Gray, A. W., 1155.
Green, G., 1140.
Greenhill, G., 1105.
Guillaume, E., 1134.
Guillet, A., 1097.
Guye, C. E., 1148, 1149.
Hanaman, F., 1170.
Hirayama, S., 1110.
Honda, K., 1161.
Ives, H. E., 1121, 1122.
Jänecke, E., 1135, 1136, 1173, 1174.
Jeans, J. H., 1116, 1117.
Juday, C., 1108.
Kaempfer, H., 1164.
Keesom, W. H., 1133.
Kingsbury, E. F., 1121.
Kruyt, H. R., 1119.
Langmuir, I., 1101.
Lees, C. H., 1104.
Liesche, O., 1172.
Lind, S. C., 1131.
McIntosh, J., 1126.
Marage, 1144.
March, A., 1137.
Martin, C., 1112.
Martin, H. H., 1107.
Mathewson, C. H., 1169.
Meslin, G., 1145.
Moore, R. B., 1131.
Nicaise, C., 1165.
Nishikawa, S., 1156.
Northrup, E. F., 1157.
Nutting, P. G., 1139.
Onnes, H. K., 1133.
Parsons, C. L., 1131.
Phillips, C. E. S., 1154.
Plummer, H. C., 1112.
Rayleigh, 1100, 1141.
Rossi, A. G., 1158.
Russo, G., 1106.
Sanford, F., 1151.
Schaefer, O. C., 1131.
Schidlof, A., 1099.
Schirmeister, H., 1171.
Schoch, E. P., 1179.
Sherrer, P., 1130.
Siegbahn, M., 1129.
Sizes, G., 1143.
Snethlage, H. C. S., 1175.
Stenström, W., 1129.
Störmer, C., 1118.
Takagi, H., 1161.
Targonski, A., 1099.
Tawara, K., 1161.
Taylor, E. G., 1128.
Teillard, A., 1162.
Thalheimer, E. M., 1169.
Thompson, F. C., 1098.
Thornton, W. M., 1153.
Troland, L. T., 1124.
Uller, K., 1102.
Verschaffelt, J. E., 1165.
West, G. D., 1120.

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

OCTOBER 1916.

GENERAL PHYSICS.

1097. *Kinematic Representation of a Damped Harmonic Function.* **A. Guillet.** (Journ. de Physique, 6. pp. 47–66, Jan.–Feb., 1916.)—The variation of $u = ae^{-\lambda t} \sin wt$ can be represented as the abscissa of a point M which moves along an arrow OS according to $OM = ae^{-\lambda t}$ while the arrow OS turns about O with a constant angular speed ω. The author develops this idea, and shows how the velocity and acceleration of the point at any moment are represented, and investigates the effect of impulses applied to a body moving with damped harmonic motion. A system operated in this way occurs in the "autoballistic repeater" [Abs. 1298 (1908)] and in a galvanometer maintained deflected by successive rhythmic discharges, both of which cases the author investigates. W. H. G.

1098. *Surface-tension Effects in Metals.* **F. C. Thompson.** (Iron and Steel Inst., J. 93. pp. 155–193; Disc. and Corres., 194–210, 1916. Engineering, 101. pp. 472–474, May 19; 513–514, May 26, and pp. 540–542, June 2, 1916.)—The author has extended the theory which has already been described in Abs. 278 (1916). In applying the theory to the case of steels generally, the author shows that it gives a simple and rational explanation of the direct linear relationship of the mechanical properties of plain carbon steels up to a carbon content of 0·9%. The increase of the elastic limit by alloying with a third element is also compatible with the demands of the theory. The conditions governing the hardness or tensile strength and its elastic limit, though parallel, are quite distinct from each other. Hardness appears to be a function of the crystalline portion, while the elastic limit seems to depend chiefly on the intercrystalline cement. F. C. A. H. L.

1099. *Brownian Movement of Particles of Oil, Tin, and Cadmium in different Gases and at different Pressures.* **A. Schidlof** and **A. Targonski.** (Comptes Rendus, 162. pp. 788–791, May 22, 1916.)—The authors have made observations on the Brownian movement of (1) olive-oil drops, of spherical form and definite density, in the air at the ordinary pressure and at a pressure of about 0·05 atmo.; (2) particles of tin obtained by pulverisation of the molten metal in an atmosphere of nitrogen; and (3) particles of cadmium produced by the ebullition of Cd in pure hydrogen and in hydrogen containing a little air. The results show that Einstein's theory of Brownian movement is applicable to spherical particles (spherules of oil) without restriction, and to non-spherical particles of not too irregular form (particles of Sn and Cd), no matter what the gaseous medium. The value of the elementary charge of the gaseous ions is in agreement, within the limits of accuracy of the measurements, with that obtained by other more exact methods [see Abs. 156, 231, 591 (1916)]. T. H. P.

1100. *Discharge of Gases through Nozzles.* **Rayleigh.** (Phil. Mag. 32. pp. 177–187, Aug., 1916.)—Discusses the problem of the flow of gas through a small aperture from one vessel to another in which the gas is at a much lower pressure, with special reference to the work of Emden and of Prandtl [see Abs. 1836 (1899) and 3 (1905)]. It is suggested that further experimental evidence is required as to whether any alteration in the rate of discharge is caused by reducing the pressure in the receiving vessel beyond a certain critical point. A simple form of apparatus for carrying out this test is described. J. W. T. W.

1101. *The Evaporation, Condensation, and Reflection of Molecules and the Mechanism of Adsorption.* **I. Langmuir.** (Phys. Rev. 8. pp. 149–176, Aug., 1916.)—The author commences by dealing with R. W. Wood's experiments in which a stream of mercury atoms is caused to impinge upon a plate of glass held at a definite temperature. With the plate at liquid-air temperature all the mercury atoms are condensed on the plate, whereas with the plate at room temperature all the atoms appear to be diffusely reflected. Wood seems to consider that it is a real case of reflection, but the author here suggests an alternative way of interpreting the experiments. Taking the example that all the atoms of mercury which strike the plate condense, no matter what may be the temperature of the plate, then at higher temperatures the condensed atoms may re-evaporate again so rapidly that the surface remains practically free from mercury. The two phenomena of re-evaporation and true reflection are quite distinct, and the difference would be manifest if the so-called reflection were studied at intermediate temperatures. In the case of reflection the number of atoms reflected would always be proportional to the number striking the surface, whereas, on the re-evaporation theory, the number leaving the surface can never exceed the normal rate at which mercury evaporates into a perfect vacuum. The author's experiments have convinced him that molecules and atoms of all kinds show little or no tendency to be reflected from a solid surface against which they strike. In the case of metal vapours condensing on the corresponding metals, the evidence indicates that not over one atom per thousand is reflected. With molecules of the so-called permanent gases striking surfaces covered with adsorbed films of gas molecules, there is some evidence that a certain amount of reflection may occur. When hydrogen molecules strike a hydrogen-covered surface at high temperatures it is possible that up to 81 % of the molecules are reflected, but this appears to be the maximum, and with gases other than hydrogen and helium the amount of reflection is always less than 50 %, no matter what may be the nature of the solid surface.

The first part of the present paper deals with the accumulated experimental data on the subject. Previous work on the rate of evaporation of tungsten filaments in a high vacuum led to the following relation being derived between the vapour pressure p and the rate of evaporation m, namely: $m=(1-r)\sqrt{(Mp/2\pi RT)}$, where M is the molecular weight of the vapour, R the gas constant, and r the coefficient of reflection of the vapour molecules which strike the surface. Putting $r=0$, this formula was used to calculate the vapour pressure of tungsten from the rate of evaporation. Subsequently the vapour pressures of Pt and Mo were determined by the same method. Unpublished experiments have also been made with Ag, Au, Fe, Cu, and Ni, those with silver being in agreement with independent results for the vapour pressure obtained by v. Wartenburg. Hertz opined in 1882 that the rate of evaporation of mercury at 100° into a perfect vacuum could not exceed 0·016 gm. per cm.^{2} per sec., a result not far from that obtained by the present author. From Hertz's experimental result together with the author's calculations it is concluded that at least 15 % of all the mercury atoms striking the surface must condense. Close examination of Hertz's experimental conditions indicate his result as being much too low and that the amount of real reflection is very small. Knudsen's recent work supports these conclusions, which are extended to W, Pt, Cu, Au, Ag, Mo, C, Fe, Ni, and Th. It therefore seems reasonable to conclude that the reflectivity of metal atoms striking surfaces of the same metals at room temperature (or lower) is zero. With respect to higher temperatures Knudsen's work with mercury has shown that the reflectivity with this metal remains zero even at temperatures where the vapour pressure of the metal becomes fairly high, and in other cases the coefficient of reflectivity changes very little if at all with temperature. The question of application to non-metallic substances has still to be solved. The author discusses, "Heat Conduction in Gases at Low Pressures," "The Slip in Gases at Low Pressures," and "Statistics of Chemical Reactions" from the standpoint of reflectivity; he shows that the reflectivity of oxygen, hydrogen, and CO molecules is small even at temperatures of 900° K., and that there is every reason to believe there is no increase at higher temperatures.

The second part of the paper deals with theoretical considerations, since the phenomena of condensation, evaporation, and reflection of molecules are closely related to those of the viscosity, heat-conductivity, and adsorption of gases at low pressures. A method is derived of calculating the probability that an atom on the surface of a solid may have a sufficient velocity to cause an incident molecule to be reflected. Two assumptions, however, had to be made: (1) that the forces and motions involved are all normal to the surface; (2) that the collisions are perfectly elastic, and that the work done on the incident particle by the attractive forces all appears as kinetic energy of this particle. As both these assumptions cannot correspond with the facts, the actual probability must be very much less than the calculated value. The problem is similar to that of a calculation of the "time of relaxation" for a gas. It is probable that atoms of metal vapour striking the surface reach practically perfect thermal equilibrium with adjacent atoms before they can possibly escape again from the surface. The amount of reflection during the condensation of metallic vapours is therefore probably extremely small. Since the high heat conductivity of metals is related to their electrical conductivity, it is concluded that free electrons play an important part in the mechanism of the condensation of metallic vapours. Metals in contact with hydrogen, however, have, even at low pressures, their surface completely covered with a layer of hydrogen atoms or molecules, and a considerable fraction of the hydrogen molecules striking other hydrogen atoms or molecules on the surface appear to be reflected. The reasons for this high reflectivity probably are: (1) the small heat of condensation; (2) the temperature very high compared to the boiling-point of hydrogen; (3) the atoms forming the adsorbed layer on the surface may be so rigidly held by the underlying metal as to increase greatly the tendency for the weakly attracted incident atoms to be reflected. As a final opinion the author states that when gas molecules strike solid bodies, in no case are more than 90 % reflected, and he gives a detailed discussion in support. H. H. Ho.

1102. *Waves of Elementary Oscillation Form in Liquids and Gases.* **K. Uller.** (Phys. Zeits. 17. pp. 302–305, July 15, 1916.)—The object of this paper is to consider sound-waves from the same standpoint as already described for elastic and electromagnetic waves of elementary oscillation type [Abs. 854 (1916)]. The acoustics of the atmosphere is mainly dealt with, and fundamental expressions are deduced for further study. H. H. Ho.

1103. *Gravitation and Temperature.* **E. H. Barton.** (Nature, 97. pp. 461–462, Aug. 3, 1916.)—P. E. Shaw's result [see Abs. 860 (1916)] as to *a variation* of gravitational attraction with temperature of the *large* mass, and that of Poynting and Phillips as to *no variation* in attraction with temperature of the *small* mass, may seem reconciled satisfactorily by the formula put forward by the latter collaborators, and quoted by Shaw [see Abs. 972 (1916)], namely:—

$$F = G\left(1 + K\frac{MT + mt}{M + m}\right)\frac{Mm}{r^2} \qquad \ldots\ldots\ldots\ldots(1)$$

where T and t are the absolute temperatures of the masses M and m respectively, placed at a distance r apart.

But it is here pointed out that this formula does not in general allow of the derivation of the attraction of a finite mass from the attractions of its component particles in the usual way by vector addition. It is shown that the attraction of two particles close together, each of temperature T, on a distant particle of temperature t, is not double the attraction of one such particle at temperature T.

It is concluded that this fact, though not a disproof of the formula, may well give us pause before accepting it, pending either (*a*) a rigorous derivation of the formula theoretically, or (*b*) some crucial experimental evidence that it is preferable to others.

The following alternative formula is then suggested:—

$$F = G(1 + \alpha\theta)\frac{M(1 + \beta T)m(1 + \beta t)}{r^2} \qquad \ldots\ldots\ldots\ldots(1a)$$

where as before, T and t are the absolute temperatures of the masses M and m, and θ is the mean, or effective, temperature of the space, whether vacuous or not, between the masses. With this formula, two particles at one temperature have double the attraction of either alone on another distant particle at a different temperature, *provided the temperature θ remains unchanged.* In other words, this new formula restores the validity of the vector addition of the component attractions. It seems, however, at first sight to have lost the power to explain the contrasted experimental results of the temperature effect of the large mass and the lack of it in the small mass. But, in the actual experiments of P. E. Shaw, might not the heating of the large mass involve an increase of θ? And again in the heating of the small mass carried out by Poynting and Phillips, the earth itself being the large mass, might not the value of θ be practically constant? If so, possibly the formula (1*a*) here suggested might prove consistent with all the experimental results just reviewed. E. H. B.

1104. *Laws of Skin Friction.* **C. H. Lees.** (Inst. Naval Architects, Trans. 58. pp. 52–64; Disc., 74–79, 1916. Engineering, 101. pp. 526–528, June 2, 1916.)—Discusses the laws of skin friction of a fluid in stream-line and in turbulent motion along a solid of great length. According to Froude the frictional resistance in stream-line motion is nearly independent of the form of the section of the body so long as the wetted perimeter of the section remains the same. But there seems to be considerable risk in extending Froude's expression, obtained by towing flat boards at speeds not exceeding 800 ft. per min., to the case of large ships moving at speeds of 26 knots. The problem may be attacked by investigating the motion of a long solid consisting of two duplicate models of the wetted section of a ship (supposed moving through a canal), placed back to back so that the water-lines coincide. This body, when towed with the speed of the ship, through a pipe of breadth equal to that of the canal and of height equal to twice the depth of the canal, would meet with a frictional resistance double that of the ship. This problem has been investigated for the special cases of elliptic and rectangular sections [see Abs. 15 (1916)]. When the speed of the body is increased past the stream-line stage, eddy currents are formed in the liquid, and for the resistance brought about by such currents there is no satisfactory theory; resort must then be had to experimental data and to empirical formulæ for extrapolation. The latter half of the paper deals with such empirical formulæ and compares the results so calculated with those obtained by experiment. In conclusion, it is stated that, pending further experiment, it seems justifiable to make all possible use of the propositions established for stream-line motions, and of the connection between the frictional resistance of pipes and of long bodies towed through fluids, when the motion in the fluid is eddying or turbulent. J. W. T. W.

1105. *Note on Echelon Waves.* **G. Greenhill.** (Inst. Naval Architects, Trans. 58. pp. 105–108, 1916. Engineering, 101. pp. 451–452, May 12, 1916.) —Such waves are seen stretching aft from the bow wave in a line of echelon, and can be watched at sea on a calm day. On a small scale the wake of a duck will exhibit the waves quite clearly. The effect is explained by a combination of interference and group velocity, and the author submits a geometrical construction to replace a long analytical calculation.

H. H. Ho.

1106. *An Experimental Tank reproducing Wave Motion.* **G. Russo.** (Inst. Naval Architects, Trans. 58. pp. 95–102; Disc., 102–104, 1916. Engineering, 101. pp. 450–452, May 12, 1916.)—The present paper is the result of work commenced 16 years ago, on the rolling of ships amongst waves. The earlier work led to the creation of the navipendulum, and of a wave-motion machine by which the problem of a ship rolling on waves was brought from the field of mathematical investigation into that of experimental research. Since the wave-motion instrument is not the sea, nor the navipendulum the ship, the production of artificial waves in experimental tanks has received profound attention. Were it possible to produce in a tank regular, continuous, and well-proportioned waves, then a method involving a model and a tank could be devised, whereby on a small scale a ship and its waters could be represented, and so the problem of the rolling on waves could be solved. The author now claims all difficulties to have been surmounted, and a tank constructed whereby a regular wave motion of a limited mass of water is produced, the length, height, and period of the wave being regulated as desired. A full description of this apparatus is given illustrated by diagrams to show construction principles, and instantaneous photographs of the machine in operation with a model of a ship freely oscillating on waves. The design of the tank is founded on the principle that in the wave motion of the sea, supposed to be regular and without disturbing causes, only the undulated profile of the wave advances indefinitely in a direction perpendicular to that of the crests and hollows, whereas any mass of water has a circumscribed and well-defined motion. The tank is then constructed so that its walls are made to take a continually changing distorted shape, by means of a mechanism external to the tank and bearing up and guiding the sides and bottom of the tank, the whole system being so contrived that the liquid contained in the tank takes a regular motion exactly resembling that of sea-waves. The mechanism affecting its walls and bottom may be adjusted to lend itself to variable arrangements, so that the regular waves produced in the liquid may, in their length from crest to crest, and in their height from crest to hollow, conform to predetermined dimensions. The apparatus furnishes means for ascertaining the behaviour of ships in a seaway, and of testing the greater or lesser influence on the rolling of any ship, of forms of hull, arrangement of weights, addition of bilge-keels, and the adoption of anti-rolling tanks, gyroscopic stabilitisers, or other similar appliances. H. H. Ho.

1107. *Haloes at Fort Worth (Texas) and their Relation to the Subsequent Occurrence of Precipitation.* **H. H. Martin.** (Monthly Weather Rev. 44. pp. 67–68, Feb., 1916.)—Gives a table of frequency of occurrence of solar and lunar haloes at Fort Worth for each month from 1910 to 1915. The mean number observed in the calendar months varies from 0·8 in Sept. to 4·0 in Jan., there being about 28 haloes in the year on the average. 26 % of the haloes are followed by rain within 18 hours, 36 % within 24 hours, 48 % within 36 hours, and 59 % within 48 hours. 82 % are not followed by rain within 60 hours. R. C.

1108. *Horizontal Rainbows on Lake Mendota.* **C. Juday.** (Monthly Weather Rev. 44. pp. 65–67, Feb., 1916.)—Gives a description of parabolic rainbows seen on the surface of Lake Mendota, usually in the autumn. Each bow has its apex in front of and near the observer, who has his back to the sun. The arms of the bow stretch away on either side. One example consisted of primary and secondary bows. The primary comprised spectra of colours thrice repeated, the order of colours being red outside to violet inside. Outside this was seen a portion of a secondary bow in which the order of colours was reversed. The conditions under which bows are seen are :—(*a*) A scum or film on the surface of the water, which may consist of an oily soot or of plankton organisms, (*b*) a fog which deposits minute drops of water on the scum, (*c*) a perfect calm which facilitates the formation of the scum and also permits the globules of moisture to remain as individual droplets ; (*d*) a bright sun. The explanation of the bow follows the lines of that of the ordinary rainbow. The parabolic (or hyperbolic) shape is the section of the colour cones by the surface of the water. R. C.

1109. *Temperature of the Ocean below the 500-fathom Line on the West Coast of America.* **A. H. Clark.** (Washington Acad. Sci., J. 6. pp. 413–417, July 19, 1916.)—The observations upon which this discussion is based were made from the *Albatross* off the west coast of America from Chile to the Behring Sea.

The most striking feature of the abyssal temperatures at depths exceeding 2000 fathoms is the small range of maximum variation, which is about 1 deg. F. The observed temperature at each depth is compared with the average for all the oceans at that depth as obtained by Murray and Hjort, and the following general results are obtained:—Temperatures are all above the average from Chile to the Gulf of California, and are all below the average from the Gulf of California to the Behring Sea. They are considerably below the average off South California and the Gulf of Alaska, and slightly below from Central California to Alaska. It is supposed that the equatorial counter-current flowing eastward is deflected mainly to the south by the California current flowing southward, and that this condition of affairs accounts for the result given. R. C.

1110. *Photographic Determination of Latitude.* **S. Hirayama.** (Math. Phys. Soc., Tōkyō, Proc. 8. pp. 460–464, June, 1916.)—A description is given of the application of photography with an ordinary camera, fitted with spirit-level and triangular support, to the determination of latitude, with special reference to its applicability to exploration work, without needing any knowledge of the local time and longitude. The examples quoted show only errors of less than a second of arc, using a camera lens of 27·2 cm. focal length.
C. P. B.

1111. *Surface Currents of Jupiter during* 1915–1916. **S. Bolton.** (Roy. Astron. Soc., M.N. 76. pp. 634–636, May, 1916.)—During the favourable opposition of Jupiter in 1915, 2189 transits of dark and light markings were obtained between 1915 Sept. 9 and 1916 Feb. 9, made with the 26-in. reflector at Bramley, near Leeds. The more prominent phenomena are tabulated, with the resulting rotation periods. The spots at the southern edge of the north equatorial belt exhibited a marked acceleration of velocity, while the corresponding ones along the north edge of the south equatorial belt moved at the normal rate of 9h. 50m. 27·8s., the difference between the two currents being 2·9 secs. The spot charts show the inconsistency of the rates of motion of the individual spots in nearly all latitudes, the longitudinal drift even of the Red Spot never for any considerable period remaining constant. C. P. B.

1112. *Irregular Variable R.S. Camelopardalis.* **C. Martin** and **H. C. Plummer.** (Roy. Astron. Soc., M.N. 76. pp. 612–627, May, 1916.)—The variability of this star, BD + 79·286° or A. G. Kazan 1654, was discovered from photographic plates by Madame Ceraski in 1905. The observations have been made during more than four years by means of photographs taken with the 15-in. reflector at Dunsink. During this interval the range of brightness was never more than one magnitude, from 9·7 to 10·7. A long discussion is given of the analysis of the observations for evidence of periods from 40 to 960 days.
C. P. B.

1113. *Observations of V Cassiopeiæ.* **A. N. Brown.** (Roy. Astron. Soc., M.N. 76. pp. 606–612, May, 1916.)—A table is given of 242 observations of this long-period variable, discovered by Anderson in 1898, with indications of 9 maxima and 10 minima occurring between 1910 June 8 and 1916 April 14, which are shown in a diagram. The deduced period is 226·6 days. (Harvard College Observatory period, published in 1907, is 231·5 days.) C. P. B.

1114. *Observations of Double Star, Krueger* 60. **E. E. Barnard.** (Roy. Astron. Soc., M.N. 76. pp. 592–606, May, 1916.)—Observations of this star are important on account of its being a binary system in comparatively rapid motion, and also because of its relative proximity to the solar system. A table is given showing measurements of position angle, distance, and hour angle for measurements since 1909, and new diagrams are given showing the new determinations of orbit; also reproductions from photographs taken with the 40-in. Yerkes refractor in 1908 July and 1915 Sept., showing quite clearly the motion of the closer pair with respect to the distant companion, and also the orbital motion of the components of the closer pair. The parallax is $+0{\cdot}249''$. C. P. B.

1115. *Galaxy of B Stars.* **C. V. L. Charlier.** (Roy. Astron. Soc., M.N. 76. pp. 589–592, May, 1916.)—Examination of the proper motions and radial velocities of the B stars shows that they form one well-defined cluster, which from a relatively dense centre gradually grows thinner until a distance of 150–200 siriometres is reached, after which no more of these stars are found. The centre of the cluster, assumed to coincide with the centre of the solar universe, is in the direction $\alpha = 7{\cdot}7\text{h.}$; $\delta = -55{\cdot}6^\circ$, in the constellation Carina, and is about 18·2 siriometres distant from the sun. Regarding the distribution of the stars of this type, the cluster has an extension nearly three times as great in the Milky Way as perpendicular to it. Further details are to be published in a complete memoir in the Lund Observatory *Meddelande.* C. P. B.

1116. *Law of Distribution in Star Clusters.* **J. H. Jeans.** (Roy. Astron. Soc., M.N. 76. pp. 567–572, May, 1916.)—In a star cluster having a steady state the form must be spherical, and the conditions of equilibrium for such globular clusters are investigated. The result indicates that the density in the globular cluster falls off as $1/r^4$ at great distances from the centre. C. P. B.

1117. *Theory of Star-streaming.* **J. H. Jeans.** (Roy. Astron. Soc., M.N. 76. pp. 552–567, May, 1916.)—In a previous paper [Abs. 814 (1916)] it has been shown that the known laws of star-streaming could not be interpreted in terms of the hypothesis that the universe had already reached a steady state. Following the idea of the stellar universe being made up of intermingling clusters, an analysis is made of the dynamics of collision when one moving cluster encounters another moving cluster or a random assemblage of stars, with the determination of the law of distribution of velocities resulting from the phenomenon. The main result of a single encounter is found to be a spreading out of the cluster into a disc, which will continue to expand as time goes on. C. P. B.

1118. *Aurora Borealis Observations in* 1913. **C. Störmer.** (Terrest. Magn. 21. pp. 45–56, June, 1916.)—Previous communications have been made on part of the material accumulated during the spring of 1913 by the special expedition to Bossekop and Store Koranes [see Abs. 815 (1916)]. The present paper deals with the results from 90 auroral photographs obtained on March 16, 17, 18, 21, 22, 24, and 29, with a base of 27·5 km. The altitudes present the same general features as before, the chief characteristic being the predominance of aurora about the altitude of 100–110 km. Detailed analysis of several typical stereograms furnishes additional support to the author's view of the presence of corpuscular rays in the atmosphere. C. P. B.

LIGHT.

1119. *Doubly Refractive Sol of Vanadium Pentoxide.* **H. R. Kruyt.** (K. Akad. Amsterdam, Proc. 18. No. 10. pp. 1625–1631, 1916.)—Examination of a diluted vanadium pentoxide sol [compare Diesselhorst and Freundlich, Abs. 671 (1916)] in the cardioid ultramicroscope reveals peculiar interference images consisting of long, pale blue streaks, at least 20 times as long as wide, in gentle Brownian movement and small round, briskly moving discs interspersed. In the slit ultramicroscope with a Biltz cuvette, only particles in a position perpendicular to the axis of the illuminating beam, with a deviation of at most 30°, are seen. Further, under the influence of electric cataphoresis, the particles range themselves parallel to the direction of the electric current, so that, when the cataphoresis is brought about parallel to the illuminating beam all elongated particles disappear from the field of vision; when the current is broken the normal image reappears. These observations confirm Diesselhorst and Freundlich's hypothesis and the author's assumption that the elongated particles would be invisible when situated with their long axes parallel to that of the illuminating beam. The disappearance of the interference images may also be observed, without the ultramicroscope, by means of the Tyndall phenomenon. T. H. P.

1120. *Pressure of Light by Metal-foil.* **G. D. West.** (Phys. Soc., Proc. 28. pp. 259–273, Aug., 1916. Electrician, 77. pp. 741–742, Sept. 1, 1916. Abstract.)—The pressure of the radiation emitted by a carbon-filament lamp at a distance of a few cm. is sufficient to cause a microscopically measurable deflection of the end of a strip of gold- or aluminium-foil suspended in a closed test-tube. By this means the radiation-pressure may be measured, and the results may be checked by a comparison with the energy density of the radiation, as deduced from the initial rate of rise of temperature of an exposed blackened copper plate.

In 1913 experiments were recorded carried out in atmospheres of air and hydrogen, and at pressures extending from 76 cm. to 1 cm. of mercury. The present paper deals with experiments at pressures from 1 cm. of mercury down to the highest exhaustions that could be reached.

As the pressure is lowered certain gas-action effects make their appearance, but, inasmuch as there is no appreciable difference of temperature on the two sides of the strip, the effects are somewhat different from those which occur in the ordinary type of Crookes' radiometer. When the surface of the strip is closer to one side of the containing vessel than to the opposite side, a deflection away from the closer side occurs, and the direction of this deflection is independent of the side of the strip on which the radiation falls. With a symmetrically-placed strip the deflection should be negligibly small. An explanation of these effects is suggested in the present paper, and a special type of radiometer described.

The nature of the residual gas in the tube does not seem to be very important, but it is found that the repulsive force (or thermo-kinetic reaction) acting on the strip increases with decreasing pressure, until a maximum is reached at about 0·002 cm. of mercury. With further reduction of pressure a progressive decrease takes place.

Experiments on the pressure of light may be advantageously carried out as far below the maximum as possible, or as far above the maximum as convection currents will permit. The latter alternative is the easier, and has seemed to give more consistent results. E. H. B.

1121. *Mechanical Equivalent of Light.* **H. E. Ives** and **E. F. Kingsbury.** (Phys. Rev. 8. pp. 177–190, Aug., 1916.)—Describes the method of obtaining the mechanical equivalent of light (m) from the brightness of a black body and shows that an exact value cannot be expected by this method until the black-body constants are better established than at present. The value of m is given by the expresssion $(1/b\pi)\int_0^\infty J_\lambda L_\lambda d\lambda$, where b is the brightness, in candles per unit area, of the radiator, J_λ is the rate of energy emission of the radiator for the wave-length interval $d\lambda$, at the wave-length λ, in watts per unit area, L_λ is the luminosity of the equal energy spectrum at any wave-length, in terms of $L_{\lambda\,(\mathrm{max.})} = 1$, and π is the factor transforming total (hemispherical) radiation, to radiation per steradian. There are two sets of requirements which must be fulfilled before the accurate values of m can be expected. These are: (1) the conditions controlling the emission of energy (*e.g.* temperature) must be subject to accurate measurement, and the relation between the controlling conditions and the resultant radiation must be accurately known, as, for instance, by a formula like the Planck equation. The values of the constants entering into this relation must be well established. (2) An absolutely essential condition is that the photometric method used to determine the brightness of the radiator shall be in exact agreement with the luminosity curve used in the calculation formula (L_λ). It is pointed out that the value of m varies directly as σ (the Stefan-Boltzmann constant) and that this value has been as much as 10 % in doubt until quite recently, while the present uncertainty in the value of c_2 in the Planck equation (14,200 to 14,500) corresponds to 15 or 20 % uncertainty in the value of m. It is clear, then, that even when the photometric part of the work meets the essential requirement above stated, a considerable uncertainty remains on the purely physical side. As a consequence the method cannot be expected to give, as yet, an accurate value for the mechanical equivalent of light, though it does serve to give an excellent check on the order of magnitude of this constant. The values obtained by v. Pirani and Miething and by Meyer [see Abs. 1435 (1915) and 182 (1916)] are critically discussed on this basis and a new set of experimental determinations is described, care being taken to ensure exact correspondence between the photometric observations and the spectral luminosity curve used for the calculation of L_λ. These experiments were made (1) with an ordinary black-body furnace, (2) with a Pt wedge, and (3) with a gold wedge black body. Using probable values for the black-body constants, the mechanical equivalent of light was found to lie between 0·00139 and 0·00195 watt per lumen, where "light" is defined by the spectral luminosity curve determined by Kingsbury [see Abs. 556 (1916)].

J. W. T. W.

1122. *Platinum Standard of Light.* **H. E. Ives.** (Lighting J. 4. pp. 150–152, July, 1916.)—Summarises past work on the Violle and other proposals for a platinum standard of light, and suggests the use of a standard consisting of a black body maintained at the temperature of melting Pt and radiating one watt of energy in the luminous part of the spectrum. One of the advantages of this standard is that it matches in colour the 4-watt carbon standards at present in use. J. W. T. W.

1123. *Cold Light.* **Dussaud.** (Comptes Rendus, 163. pp. 29–30, July 10, 1916.)—Describes an arrangement in which a beam of light traverses two lenses between which is maintained a current of air which dissipates the heat energy so that the light traversing the second lens is practically cold. By means of such a light it is possible to project on a screen in a lighted room images of living objects or of the pictures in a book. J. W. T. W.

1124. *The Heterochromatic Brightness Discrimination Threshold.* **L. T. Troland.** (Frank. Inst., J. 182. pp. 112–114, July, 1916.)—While it is difficult to make a positive judgment of the exact point of equality of brightness in the case of two different colours, it is easy to establish the point at which *inequality of brightness* clearly exists. Consequently for any pair of colours a brightness discrimination threshold, which is a function of the variation between them, can be determined. In these investigations four standard wave-lengths, namely 693, 575, 505, and 475 $\mu\mu$, were selected and were compared in turn with each other and with nine additional intermediate colours. The relative intensities were found at which the standard colour was (*a*) just noticeably brighter, (*b*) just not noticeably brighter, (*c*) just noticeably darker, and (*d*) just not noticeably darker. From these four values the fractional threshold of brightness discrimination can be determined. Results were obtained for an experienced and an inexperienced observer and are assembled in tabular form. The highest value of the threshold recorded is approximately seven times that characteristic of homochromatic comparison. J. S. D.

1125. *Image Formation by Crystalline Media.* **H. F. Dawes.** (Phil. Mag. 32. pp. 248–261, Aug., 1916.)—Laws for the image position are developed for a number of typical cases of image formation by the extraordinary ray in uniaxial crystals. In the examples of light travelling along the axis of the crystal, the thickness of the crystal traversed enters into the expressions for image position as if the index were n_2^2/n_1 as compared with isotropic substances; n_1 and n_2 are the principal indices of the crystal. This quantity may be considered as a sort of pseudo-index applicable to such cases. It is shown that lenses of crystal will in general form two series of images, corresponding to the two sets of waves; the laws for the image series due to the extraordinary waves correspond to those for lenses of isotropic substances, and expressions are found for the dioptric power. The question of the use of crystal components in lens systems is also considered briefly. A. W.

1126. *Black Backgrounds for Opaque Microscopic Objects.* **J. McIntosh.** (Phot. J. 56. pp. 136–140; Disc., 140–145, April, 1916.)—Discussion of various methods; method of preparing brass blackened by chloride of antimony. A. D.

1127. *A New Modification of the Ionisation Method of Measuring X-rays.* **H. E. Donnithorne.** (Röntgen Soc., J. 12. pp. 77–81; Disc., 81–83, July, 1916.)—A method of estimating the output of an X-ray tube is described which, it is claimed, gets over some of the difficulties experienced hitherto in such measurements. The rays are passed into a cell consisting of a flat ionisation chamber whose electrodes have been treated with a substance to increase the ionisation currents. This is connected by a lead to a galvanometer, the lead being guarded in the usual way by an earthed tube. The cell is placed where the photographic plate is to go and a reading taken. From this the proper exposure can be estimated. Another method is to put the cell directly behind the plate when ready to be exposed, so that the rays pass through it after traversing the plate. In this case the exposure is made whilst the reading of the galvanometer is taken. As the measurement of the rays is made after the rays have passed through the body to be photographed, all difficulty as to estimating the quantity absorbed by the body disappears. Results obtained with the instrument are compared with those observed simultaneously on other types of instruments. E. A. O.

1128. *Passage of X-rays through Narrow Apertures.* **E. G. Taylor.** (Phys. Rev. 8. pp. 207–208, Aug., 1916. Phys. Zeits. 17. pp. 316–318, July 15, 1916.)—Laub [Abs. 677, 868, 1424 (1914), 1678 (1915)], as a result of experiments in which X-rays were allowed to pass the boundaries of various opaque substances, advanced the hypothesis that the photographic records obtained were essentially a "diffraction" effect. He assumed that in the mechanical production of the apertures micro-crystalline structures were formed on the aperture surface and the X-rays were diffracted by these crystals. The author now suggests a much simpler alternative hypothesis and produces photographs in support of his views. He considers that the "diffraction" bands observed are the astigmatic slit-hole images of radiating areas of unequal intensity in the focal region of the antikathode. A. B. W.

1129. *X-ray Spectra of the Elements Na to Cr.* **M. Siegbahn** and **W. Stenström.** (Phys. Zeits. 17. pp. 318–319, July 15, 1916.)—In an earlier paper [Abs. 680 (1916)] a description was given of a determination of the X-ray spectra (K series) of the elements Ce and Cr. With the latter element the absorption in the X-ray tube and in air becomes serious, and modifications in the previous method become essential. The results of the research are included in the subjoined table.

	$\lambda \times 10^8$ cm.					
Element.	α_2.	α_1.	α_3.	α_4.	β_1.	β_2.
26 Fe	1·932	1·928			1·748	1·736
25 Mn	2·097	2·093			1·902	1·892
24 Cr	2·288	2·284			2·079	2·069
23 Va	2·502	2·498			2·281	
22 Ti	2·746	2·742	2·729		2·509	2·492
21 Sc	3·032	3·028	3·011		2·778	
20 Ca	3·359	3·355	3·328		3·086	3·074
19 K	3·738	3·735	3·724		3·449	
18 Ar						
17 Cl	4·712		4·692		4·394	
16 S	5·360		5·317	5·314	5·018	(5·029)
15 P	6·168		6·129	6·122	5·808	(5·853)
14 Si	7·131		7·088	7·080	6·759	
13 Al	8·360		8·310	8·300	7·986	
12 Mg	9·915		9·856	9·845	9·477	
11 Na	11·951					

A. B. W.

1130. *Interference of X-rays—employing Amorphous Substances.* **P. Debye** and **P. Sherrer.** (Phys. Zeits. 17. pp. 277–283, July 1, 1916.)—In an earlier publication [see Abs. 1271 (1915)] one of the authors suggested that it may be possible to determine experimentally not only the number, but also the order of arrangement of the electrons inside an atom. To prove the existence of such an orderly arrangement of *electrons* the use of crystalline substances is, of course, impossible, as the results would be complicated by the effects produced by an orderly arrangement of *atoms*. To overcome this difficulty, the authors propose to use a collection of atoms irregularly orientated with regard to each other, *i.e.* to use non-crystalline, or amorphous, substances. With the above object in view the experiments described in the present paper have been carried out. The following substances were used in the investigation: graphite, amorphous boron, amorphous silicon, lithium fluoride, etc. These substances were pulverised and pressed into cylindrical rods of 2 mm. diam. and 10 mm. length. One of these rods was placed in the middle of a cylindrical camera of 57 mm. diam. After passing through a long lead tube of 2·5 mm. bore, a beam of homogeneous X-rays falls on the rod, the reflected beam being photographically recorded on two curved pieces of film lying on the cylindrical walls of the camera. In this manner the radiation can be collected over an angular range extending from 90° to 171°, corresponding to a length of film of 80 mm. The resulting photographs, of which excellent reproductions are shown, consist of a symmetrical arrangement of sharp lines, bearing some resemblance to the pattern produced when polarised light traverses a biaxial crystal.

A theoretical discussion is given, and the experimental results are analysed in detail. The values of "*a*," the length of the side of the elementary cube, are calculated for the elements Li, Si, and C.

For Li, $a = 4{\cdot}14 \times 10^{-8}$ cm.; for Si, $a = 5{\cdot}46 \times 10^{-8}$ cm.; and for C, $a = 4{\cdot}69 \times 10^{-8}$ cm. The shortest distance apart of the silicon atoms is shown to be $2{\cdot}33 \times 10^{-8}$ cm. A. B. W.

RADIO-ACTIVITY.

1131. *Extraction and Recovery of Radium, Uranium, and Vanadium from Carnotite.* **C. L. Parsons, R. B. Moore, S. C. Lind,** and **O. C. Schaefer.** (Bureau of Mines, Bull. 104. [124 pp.], 1915.)—This publication gives a detailed description of the commercial separation of radium from carnotite. The work has been carried out as a result of a co-operative agreement of the National Radium Institute and the Bureau of Mines. After a lengthy introduction, in which the details of the plant, etc., are considered, the different methods of treating radium ores are given in great detail. Especial emphasis is laid on the Bureau of Mines method for treating carnotite. This is followed by a description of the methods of refining radium. Methods of measuring quantities of radium, recoveries and losses in the various manufacturing processes, and cost data are fully discussed.

A comprehensive abstract of this paper is impossible; reference should be made to the original. A. B. W.

1132. *Photo-electric Effect and β-radiation of Radio-active Substances.* **P. S. Epstein.** (Phys. Zeits. 17. pp. 313–316, July 15, 1916.)—A theoretical paper dealing with the application of the quantum theory to the "Rutherford-Bohr" atom. A. B. W.

HEAT.

1133. *Specific Heat at Low Temperatures.* III. *Specific Heat of Solid Nitrogen between 14° K. and the Triple Point and of Liquid Nitrogen between the Triple Point and the Boiling-point.* **W. H. Keesom** and **H. K. Onnes.** (K. Akad. Amsterdam, Proc. 18. No. 8. pp. 1247–1255, 1916. Comm. No. 149a. from the Phys. Lab., Leiden.)—By means of a special apparatus, described in detail, the specific heats of solid and liquid nitrogen have been measured, the results agreeing in general with those recently obtained by Eucken (Deut. Phys. Gesell., Verh., Jan. 15, 1916). The triple point of nitrogen is found to be 63·06° K. [see Fischer and Alt, Abs. 1029 (1903); Holst, Abs. 212 (1916)]. The results obtained with solid nitrogen, particularly the specific heats at liquid hydrogen temperatures—at which $(C_p - C_v)$ very probably has still small values—show that the behaviour of nitrogen differs from that of solid monatomic substances such as copper, lead, etc. Hence nitrogen in the solid state is presumably diatomic, that is, the crystal space-lattice is composed of two point-systems placed one inside the other so that a new frequency is introduced by the vibrations of the two point-systems with respect to each other. The atomic heat of solid nitrogen varies from 1·60 at 15·27° K. to 5·48 at 61·68° K., that of liquid nitrogen at 63·95–76·49° K. being 6·48–6·87; thus the sudden increase of the atomic heat at the triple point is about 1·3 gm. cals. The values found for the specific heat of liquid nitrogen, 0·462–0·490, are considerably higher than Alt's mean value, 0·430, at 65–77° K. T. H. P.

1134. *Generic Entropy and Gaseous Mixtures.* **E. Guillaume.** (Archives des Sciences, 41. pp. 445–456, June, 1916.)—The author has previously deduced formulæ for the "statistical entropy" of a monatomic gaseous mass [see Abs. 1606 (1915)]. When, however, the results generally admitted in classical thermodynamics are compared with the consequences of the statistical theory, many difficulties are encountered. In the present communication some of these, including the "paradox of Gibbs," are discussed, the paper being highly mathematical. It is concluded that the statistical theory is in perfect accord with the general results connected with the principles of entropy in the case of a gas, and that no additional hypotheses need be invoked. T. B.

1135. *Press for Studying Melting-points and Transition Phenomena.* **E. Jänecke.** (Zeits. Phys. Chem. 90. pp. 257–264, Sept. 24, 1915.)—An electrically-heated press for pressures up to 30,000 kg., first designed for studying fusion phenomena in natural and artificial potassium salts, has been found useful for determining melting-points and transition phenomena of salts, metals, and alloys. The press, made by Amsler, is a vertical steel cylinder 140 mm. high, 80 mm. bore, in which three steel blocks are superposed on one another. The substance rests on the top block underneath the plunger, which is worked by oil; the three blocks are so perforated that the melting substance can flow down, but that solid particles cannot drop. Melting or transition is marked by a change in the pressure which is recorded by the pendulum manometer of Amsler, correct within 0·05 % at

700 kg./cm.². A chrome-nickel resistance furnace is slipped over the press within its frame, temperatures being measured by a copper-constantan couple. H. B.

1136. *Determination of the Melting-points of Gypsum, Soda, Borax, Copper Sulphate, Carnallite, etc.* **E. Jänecke.** (Zeits. Phys. Chem. 90. pp. 265–279, Sept. 24, 1915.)—Using the press described [see preceding Abs.] and about 20 gm. of substance, previously compressed sometimes, the author finds that gypsum $CaSO_4, 2H_2O$, begins to soften above 81° under a pressure of about 2750 kg. (applied in steps of 250 kg.), melts and is converted into $CaSO_4, \frac{1}{2}H_2O$; $Na_2CO_3, 2H_2O$ melted at 107° and became anhydrous; $BaCl_2, H_2O$ also melted and lost its water at 100°. $Na_2B_4O_7$ was converted into a salt with $8H_2O$. Copper sulphate showed the three hydrates already known and probably a fourth, $CuSO_4, \frac{1}{2}H_2O$. Carnallite, $KCl . MgCl_2 . 6H_2O$, was fused under pressure at 168°; after removal of the residue by increasing the pressure, KCl alone was left. H. B.

1137. *On the Kinetic Theory of Evaporation.* **A. March.** (Phys. Zeits. 17. pp. 299–302, July 15, 1916.)—The determination of the dependence of the pressure of saturated vapours on temperature has been the object of much theoretical investigation. Those attempts proceeding purely from the thermodynamical standpoint assume the heat of evaporation to be a linear function of the temperature, apply the laws for a perfect gas to vapours, and neglect the specific volume of the liquid in comparison with that of the gas. The general result, known as the Dupré–Rankin equation, is of the form $\log p = A - B/T - C \log T$, where p is the vapour pressure, T the absolute temperature, and A, B, C are constants, and this is in excellent agreement with experiment if the values of the constants are determined from observed data. On the other hand, attempts have hitherto failed to deduce the constants from purely theoretical thermodynamical grounds. The present author here considers the theory from the molecular kinetic standpoint. He finds that the heat of evaporation and the specific volume must be determined as functions of the temperature, and to determine the vapour-pressure law he describes at some length a molecular mechanical model based on critical data. The result of the investigation is to establish van der Waals' vapour-pressure formula. H. H. Ho.

1138. *Electrodynamic Interpretation of Planck's Constant "h."* **A. L. Bernoulli.** (Archives des Sciences, 42. pp. 24–31, July, 1916.)—For giving an electrodynamic interpretation to Planck's constant "*h*," the author introduces a new principle which he terms the "Principle of the Universal Flux of Induction," and which he defines as follows:—"If electrons are moving in identical closed trajectories in a molecular magnetic field, the number of lines of force cut by the radii vectores at each revolution is one and the same universal constant." In other words, all the electron-resonators are traversed by a like tube of magnetic force. The author finds that the product of the induction flux and the charge is a number which agrees not only in respect to dimensions with Planck's constant, but also as regards magnitude. Bohr's hypothesis to explain his results with respect to spectral series and atomic constitution is found to be a consequence of this new electrodynamical principle. Also the first constant of the principal series in the formula of Kayser and Runge is found to be practically identical with the product of the mean free path and the specific mass. A formula is also derived for the mass of a gaseous molecule. The agreement between theory and experiment is very close, and is shown by the numerous tables included in the paper.

H. H. Ho.

1139. *Criteria for Grey Radiation.* **P. G. Nutting.** (Washington Acad. Sci., J. 6. pp. 476–478, Aug. 19, 1916.)—If the logarithm of the energy radiated from a body within a short range of wave-lengths be plotted against the reciprocal of the absolute temperature the result is known to be a sensibly straight line over a wide range of temperatures. These logarithmic isochromatic lines pass through a common point in some cases, and not in others, and it has been assumed [see Abs. 1699 (1915)] that this stigmatic condition is characteristic of grey radiation, while the lack of it means that the radiation is selective. Hyde concludes [Abs. 698 (1916)] that the stigmatic condition is insufficient as a criterion for greyness, while Foote and Fairchild have shown further [Abs. 708 (1916)] that the stigmatic condition may hold even for a body known to be strongly selective. The question is treated mathematically in the paper, and it is shown that the logarithmic isochromatic lines representing equilibrium radiation do not form a stigmatic pencil *except for a limited range of wave-lengths.* For free radiation, the stigmatic condition gives an equation known to be of wide validity. The stigmatic condition and the condition for greyness may both be satisfied, but either may hold without the other.

J. W. T. W.

1140. *A Method of deriving Planck's Law of Radiation.* **G. Green.** (Phil. Mag. 32. pp. 229–232, Aug., 1916.)—The method described by the author was suggested by Rayleigh's paper on "The Dynamical Theory of Gases and of Radiation." The author assumes the radiating body to be a gas contained in a perfectly reflecting enclosure in thermal equilibrium, and consisting of molecules having internal modes of vibration which are identical with the modes of vibration of unit volume of ether. No molecule is assumed to emit radiation in any mode until the total energy in that mode is hf, where h is a constant and f the frequency of the mode. Maxwell's law of distribution of velocities is taken to hold throughout the gas, and implies an equilibrium condition within the enclosure maintained by collisions, statistically regular absorption, and sudden emission in each mode when the limiting energy is reached. With these assumptions Planck's law is then derived. Although the existence of a limiting energy in each mode is necessary, yet the author opines that the emission of energy need not take place suddenly when the limiting energy is reached. Emission and absorption may be continuous processes, and the attainment of the limiting energy condition may involve some other action than that postulated, such as the disruption of the molecular system with possibly very little transference of energy to the ether.

H. H. Ho.

SOUND.

1141. *Energy acquired by Small Resonators from Incident Waves of Like Period.* **Rayleigh.** (Phil. Mag. 32. pp. 188–190, Aug., 1916.)—In discussions on photo-electricity it is often assumed that a resonator can operate only upon so much of the radiation incident upon it as corresponds to its own cross-section. [See Abs. 713 (1916).] As a general proposition this is certainly not true, and may indeed differ from the truth very widely. Since 1878 it has been known than an ideal *infinitely small* acoustical resonator may disperse energy corresponding to an area of wave-front of the primary waves equal to λ^2/π, (where λ is the wave-length), an efficiency exceeding to any extent the limit fixed by the above-mentioned rule. The questions of how much energy can be absorbed into the resonator itself, and how long the absorption may take, are a little different, but they can be treated without difficulty by the method explained in a recent paper [see Abs. 844 (1915)]. In this way the author finds that the resonator is able to capture an amount of energy equal to that passing in the same time through an area of primary wave-front comparable with λ^2/π, an area which may exceed any number of times the cross-section of the resonator itself. E. H. B.

1142. *Piano with Electrically-sustained Notes.* (Engineering, 102. p. 210, Sept. 1, 1916.)—This device was invented by Maitre and Martin, and a paper upon it was read by H. Bevierre before the Society of Civil Engineers of France at Paris in July 1914. It is designed to sustain the notes of pianos or increase their sonorousness, a demonstration of a piano fitted with the device accompanying the paper. The device consists of two electromagnets, a battery, and the accessory contacts and connections. One of the electromagnets is small and referred to as the *exciter*; the other is large and may be called the *maintainer*: the two are in series with each other and the source of current. The exciter suffers interruptions of the current as the piano wire vibrates, because the wire forms part of the circuit. The maintainer accordingly suffers interruptions also, and its position on the opposite side of the wire is such that the vibrations of the piano wire are maintained. For a pianissimo effect, resistance is introduced into the circuit of the electromagnets. E. H. B.

1143. *Properties of the Law of Resonance of Sounding Bodies.* **G. Sizes.** (Comptes Rendus, 162. pp. 634–637, April 25, 1916.)—Following previous work in the detection of many partial tones in sounding bodies, the author now points out various numerical relations between them and the notes of the scale in different octaves. [See Abs. 356 (1916).] E. H. B.

1144. *Acuteness of Hearing: Deafness True and Apparent from Wounds in Action.* **Marage.** (Journ. de Physique, 6. pp. 29–43, Jan.–Feb., 1916.)—Discusses and analyses the cases of true and apparent deafness following upon wounds received in action, and the restorative treatment by means of a set of five vowel sirens. E. H. B.

1145. *Projection of Monge's Experiment.* **G. Meslin.** (Journ. de Physique, 6. pp. 44–46, Jan.–Feb., 1916.)—Describes by aid of diagrams a method of projection suitable for demonstration of Monge's experiment to an audience. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1146. *Mutual Magnetic Energy of Two Moving Point-charges.* **A. Anderson.** (Phil. Mag. 32. pp. 190–194, Aug., 1916.)—The method here given of finding the mutual magnetic energy of two moving point-charges of electricity is elementary. It does not claim to have the elegance of Heaviside's method. It is, however, a confirmation of his result by simple mathematics, in which there are no vector potentials, no curls of any kind, and no trouble of adjusting the vector potential to make the space integral of the scalar product of it and the magnetic force vanish for the polar, or displacement, currents in the medium. E. H. B.

DISCHARGE AND OSCILLATIONS.

1147. *Small Discharges in Dark Photoelectric Cells.* **J. Elster and H. Geitel.** (Phys. Zeits. 17. pp. 268–276, July 1, 1916.)—When the negative potential of an alkali-metal kathode in a vacuum tube is gradually raised until a continuous discharge sets in, slight current pulses are observed before the potential is sufficient to make the discharge continuous. These pulses become more rapid and also feebler on admitting an extremely feeble amount of light to the tube. The authors investigated this phenomenon by means of a single-fibre electrometer showing 10 scale divisions to the volt. The results go to corroborate E. Meyer's theory, according to which certain electrons acquire sufficient energy for shock-ionisation even at p.d.'s below the ordinary discharge potential. These electrons are either photo-electrons or (when radium is present) δ-rays. That they also occur in the "dark" is probably attributable to very slight illumination due to phosphorescence of the gas or the glass. Similar current pulses can be obtained by using silver kathodes without alkali-metal deposits, but only after a preliminary glow discharge. The authors attribute this to the deposition of photoelectric traces of alkali metals by decomposition of impurities in the tube. The current pulses are a very sensitive criterion for the presence of light. The authors proved this by reducing the light by successive concentrations of Indian ink in an absorbing vessel. They found that the light could thus be reduced to 1/100000 of its original intensity, and that on adding equal quantities of ink the photoelectric currents decreased in a geometrical series. The minimum energy thus observable was 8×10^{-9} erg cm.^{-2} sec.^{-1} in the case of blue light, and 2×10^{-7} erg cm.^{-2} sec.^{-1} in the case of orange light. The photoelectric effect remains proportional to the light intensity even at these feeble illuminations. As in the case of selenium, the electric discovery of light is possible beyond the limits of ocular perception, especially in the case of luminous surfaces rather than points. Special experiments showed also that the reflection of very small quantities of light is independent of the sign of the charge of an alkali-metal surface. This proves again that the photo-electrons derive their entire energy from the incident light. E. E. F.

1148. *Hypothesis of a Molecular Electrostatic Field in Compressed Gases and the Disruptive Discharge.* **C. E. Guye.** (Archives des Sciences, 42. pp. 14–19, July, 1916.)—In previous work [see Abs. 1464 (1905)] it has been shown that in the vicinity of the maximum of compressibility of nitrogen, the explosive potential has passed a maximum. It may seem strange, at first sight, when considered from the standpoint of the theory of the disruptive discharge based upon ionisation by collision, that the explosive potential should not continually increase in proportion to the pressure increase, and the present author, in search of an explanation, has contemplated the existence of a molecular electrostatic field in the interior of a compressed fluid, whose action added to that of the external field would thereby facilitate ionisation by collision and the passage of the disruptive discharge. Although at the present experimental stage it has not been possible to fix the strength of this field, yet the author considers a number of particular cases which are capable of theoretical investigation in the hope of experimental verification later. The case of a perfect gas whose molecules are far apart first receives attention, and it is found that this field is inversely proportional to the free path of the ion between two collisions, *i.e.* proportional to the number of gas molecules per unit of volume. The next case to be treated is where the fluid is sufficiently dense for the spheres of action to encroach upon each other and thereby constitute a molecular field somewhat analogous to that contemplated by Weiss for the explanation of ferro-magnetism. This molecular field is then evaluated for particular cases. Within wide limits the field is found to remain proportional to the number of molecules per unit volume. Further work is promised. [See next Abstract.]

H. H. Ho.

1149. *Equation of the Disruptive Discharge and the Possibility of Three Varieties of Explosive Potential.* **C. E. Guye.** (Archives des Sciences, 42. pp. 20–24, July, 1916.)—The theory of the disruptive discharge based upon ionisation by collision leads to the following expression for the current of discharge: $i = i_0(e^{a(\alpha-\beta)} - 1)/(\alpha - \beta e^{a(\alpha-\beta)})$, where the discharge is taken between two parallel plates, at a distance a apart, the initial ionising cause being uniformly distributed throughout the gas; i_0 is the saturation current corresponding to the initial ionising cause; α is the number of ionising collisions produced by an electron in a path of 1 cm.; β is the number of ionising collisions produced under the same conditions by the positive ion. When the ionising cause is ultra-violet light impinging on the negative plate, the denominator of the above expression preserves the same form [see Abs. 954 (1906)]. The object of this note is to show how the above equation leads to three varieties of explosive potential. The first corresponds to the condition $\alpha = \beta e^{a(\alpha-\beta)}$, $\alpha > \beta$, and is the one most frequently observed, since the explosive potential usually corresponds to the case where the current tends to become infinite, *i.e.* when the denominator of the expression vanishes. Independent of the general solution a second may be obtained when $\alpha = \beta$. In this case the expression takes the form 0/0, and only for the particular case of $\alpha = \beta = 1/a$ does the current become infinite, and so corresponds to a second explosive potential. Thirdly, the denominator vanishes for $\beta = \alpha e^{a(\beta-\alpha)}$, $\beta > \alpha$, while the numerator remains finite and the sense of the discharge is unmodified and corresponds to a third explosive potential. The author gives a graphic representation of these three explosive potentials accompanied by detailed discussion of the curves produced. A future paper will deal with the relations and experimental conditions of the three potentials now established.

H. H. Ho.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1150. *Effect of Temperature on the Light-sensitiveness of Selenium.* **E. O. Dieterich.** (Phys. Rev. 8. pp. 191–194, Aug., 1916.)—A number of Se cells of different types were studied at temperatures ranging from 22° to 127° C., and curves are reproduced showing the light-sensitiveness for wave-lengths varying from 550 $\mu\mu$ to 800 $\mu\mu$. As the temperature rises the light-sensitiveness decreases chiefly in the region of the more-refrangible rays. Where a maximum already exists in the red, that maximum may be shifted towards the infra-red, but it returns to its original position on cooling. [See Abs. 742 and 900 (1915).] E. E. F.

1151. *Temperature Coefficient of Contact Potential.* **F. Sanford.** (Phys. Rev. 8. pp. 95–96, July, 1916.)—The author, in criticising the work of Compton [Abs. 605 (1916)], states that the apparatus used by the latter is not described with sufficient detail to enable a reader to decide what has been measured, but from the meagre description given he is of opinion that Compton measured, not the temperature coefficient of contact potential, but that of electrolytic potential. I. W.

1152. *Resistance and Thermoelectric Relations in Iron Oxide.* **C. C. Bidwell.** (Phys. Rev. 8. pp. 12–19, July, 1916.)—This paper contains some results obtained with artificially prepared specimens of Fe_3O_4 and shows in particular a possible relation between thermoelectric power and electrical resistance. Most of the work of Koenigsberger on the oxides of iron deals with naturally occurring crystals of large size, the behaviour along the different axes being studied. Koenigsberger found that the specific resistance ρ, the Centigrade temperature t, the absolute temperature T, R the gas constant, and Q the heat of dissociation of the electrons, *i.e.* the heat required to liberate 1 gm.-atom of electrons from the atoms to which they are supposed to be bound, are connected by the relation $\rho = A[1 + \alpha t + \beta t^2]e^{Q/RT}$. In the present work the author found that the exponential $e^{\alpha T}$ was as satisfactory as the term $[1 + \alpha t + \beta t^2]$ and more convenient for graphical testing. Owing to the effect of high temperature on the physical condition of the specimen the order in which measurements were taken was of great importance. Measurements were taken, say for resistance, going from high to low temperature and then for thermal e.m.f. going from low back to high temperatures. In this way the specimen was not subjected to extreme high temperatures between the resistance and thermoelectric observations. Numerous curves are given, and the experimental data are fully discussed in reference to the above equations. I. W.

1153. *Cause of Lowered Dielectric Strength in H.F. Fields.* **W. M. Thornton.** (Phil. Mag. 32. pp. 242–248, Aug., 1916.)—Experiment indicates that the breakdown strength of dielectrics falls with rise of frequency of the field, up to the frequencies used in wireless telegraphy. The author further discusses this question [see Abs. 1808 (1915)]. He points out that the close resemblance between his theoretical curve and Peek's empirical curve would appear to justify the view that the observed influence of time of application on breakdown strength is largely, if not entirely, caused by the rate of growth of interattraction, and that Peek's formula might be replaced by a simpler exponential type. That dielectric hysteresis is a time and not a static phenomenon was recognised from the first, but it would appear that the use of the term "viscosity" instead of hysteresis, or as indicating the cause of it, is not tenable. The retarding force due to viscosity, if taken as usual to be proportional to rate of displacement, leads to results not in keeping with the experimental facts. Dielectric hysteresis must therefore be considered as neither a static nor a viscous retardation of displacement, but as a quasi-elastic adjustment of equilibrium of the field of interattraction between opposite charges in molecules whose (fixed) axes are in perfect confusion of alignment; the molecules being partly polarised, and interattraction started, by the application of the external field. I. W.

1154. *Experiments with Mercury-jet Interrupters.* **C. E. S. Phillips.** (Phys. Soc., Proc. 28. pp. 284–290; Disc., 291–292, Aug., 1916.)—An experimental attempt is made to ascertain the form of the mercury column issuing from a hole in the side of a rotating drum that is continuously supplied with mercury by centrifugal action. Incidentally a new form of interrupter is introduced, in which the interior is visible through a window in the lid. The arrangement forms a suitable apparatus for experiments with various forms of orifices and metallic contact segments, and an account is given of work in that direction. As it is important to secure the cleanliness of the mercury in interrupters of this type, the usual copper segments are replaced by tantalum segments. For many reasons tantalum is preferable: it is not "wetted" by mercury, it remains clean and bright indefinitely, and its high melting-point renders it lasting. Experiments with various forms of orifices are described, and it is pointed out that the issuing stream is only slightly affected by this means. An explanation is given of the fact that a vertical slit orifice will not produce a ribbon of mercury, and that no matter how much the diam. of the orifice is increased beyond about 2 mm., the cross-section of the mercury column remains unaltered. A method is described, however, by which a much larger stream of mercury can be obtained from the rotating drum, if necessary. Brief reference is made to experiments with various volatile liquids in suppressing the flare which occurs when the mercury columns leave the contact segments. The three well-known substances which are most effective in this respect are coal gas, hydrogen, and ether. It is pointed out that experiments of this nature are necessary, in view of the wide use now made of mercury interrupters in X-ray work. During the *discussion* a communicated note from **P. R. Coursey** was read in which reference is made to a special form of interrupter for handling fairly heavy currents and so devised as to make the internal operations visible. A. E. G.

1155. *Protected Thermo-elements.* **A. W. Gray.** (Bureau of Standards, Bull. 13. pp. 283–285, 1916 [Sci. Papers No. 276].)—A form of thermo-couple mounting suitable for laboratory work is described. The copper-constantan couple is insulated over the portion to be inserted into the hot region by glass capillaries and enclosed in a hard glass tube. This tube is cemented to a light copper tube which extends to the ice-box; the wires being insulated from the metal by paraffined silk covering. The ice-box is a commercial vacuum vessel the cork of which carries an insulating block to which are attached the copper tube, binding posts for connections to potentiometer, and a glass tube, projecting into the ice, which contains the cold junction. E. G.

1156. *Constant-high-potential Apparatus to be Installed in University of Tōkyō.* **K. Fuji** and **S. Nishikawa.** (Math. Phys. Soc., Tōkyō, Proc. 8. pp. 509–512, July, 1916.)—A description is given of two equipments—a high-tension d.c. generator and a three-phase transformer with kenotron rectifiers—specially designed for research work on X-rays and vacuum discharges. The d.c. generator, supplying a current of 0·1 amp. at 10,000 volts, consists of four dynamos with ring armatures, the machines being connected in series and coupled to an induction motor. The set of transformers with six kenotrons (see General Electric Review, March, 1915) is employed for the production of continuous potential up to 120,000 volts. A description is also supplied of a non-inductive resistance to be used in the high-tension side of the transformers.

For further details reference should be made to the original paper.

A. B. W.

1157. *Resistivities and Thermal E.M.F.'s of Ca, Al, and Mg.* **E. F. Northrup.** (Met. and Chem. Eng. 15. pp. 193–197, Aug. 15, 1916.)—The resistivities of Ca, Al, Mg, and four alloys of Al were determined over the temperature range, 20°–150° C. The value for Ca was 5·32 microhms-cm. at 20° C. and 6·64 microhms-cm. at 100° C. This is a little higher than the value for Mg, which was 4·75 microhms-cm. at 20° C. Although Al and Mg both have low resistivity, their alloys have a resistivity which is considerably higher than that of either of the constituents; increasing the proportion of Mg greatly increased the resulting resistivity. Thus at 20° a sample consisting of 90 Al + 10 Mg had a resistivity of 8·28 microhms-cm. while a sample containing 10 Al + 90 Mg has more than twice the resistivity, 19·18 microhms-cm. The thermal e.m.f.'s of the above-mentioned substances were determined against Cu over the range 0° to 500° C., and also that of Ni against nichrome. Ca-Cu gave about 10 microvolts/degree between 0° and 100° C. The curve for Ni-nichrome, which was taken up to the melting-point of Cu, shows a slight inflection which is attributed to a recalescence point in Ni at about 360° C. I. W.

ALTERNATING CURRENTS AND MAGNETISM.

1158. *Dynamic Transformer for Alternating Currents.* **A. G. Rossi.** (Accad. Sci. Torino, Atti, 51. 8a. pp. 392–410, 1915–1916.)—Shows how a combination of a biphase stator, in which the two windings are kept separate, with a closed rotor may act as a dynamic transformer if one of the windings be subjected to an alternating pressure while the other forms part of a secondary circuit and the rotor is set in motion by an external force.

A. D.

1159. *Paramagnetism of Palladium with Absorbed Hydrogen.* **H. F. Biggs.** (Phil. Mag. 32. pp. 131–140, July, 1916.)—A disc of palladium-foil was fitted within a small coil carried on the arm of a torsion balance which swung in a non-uniform field. From observations made with currents in the coil with and without the Pd present, the magnetic moment of the latter could be calculated. These observations were intended to answer two questions. If M_1 and M_2 be the magnetic moment, in the same field H, of the Pd with hydrogen contents v_1 and v_2 cm.^{3} at N.T.P., then the negative quantity $(M_1 - M_2)/H(v_1 - v_2)$ is called the susceptibility-gradient due to hydrogen. The questions, (1) Is the susceptibility gradient independent of the field H? and (2) Is it independent of the hydrogen contents v_1 and v_2? both receive an affirmative answer, as far as the accuracy of the experiment goes. In the course of the work, a method of designing pole-pieces to give a constant ponderomotive force was employed. G. E. A.

1160. *Sun-spots and Mean Daily Range of Magnetic Declination.* **A. L. Cortie.** (Roy. Astron. Soc., M.N. 76. pp. 631–634, May, 1916.)—In a former paper [Abs. 246 (1916)] evidence was given in support of the view that magnetic disturbances depend largely upon the heliographic latitudes of sun-spots present at the time. In the present paper a discussion is given of the declination range and the sun-spot areas and latitudes for the years 1900–1912, embracing a whole solar cycle, and curves are shown summarising the comparisons. On the rise, from 1902 to 1905, the sun-spot curve and that for declination are practically conterminous, each reaching a maximum in 1907. On the fall, however, the magnetic declination curve distinctly lags behind the sun-spot area curve. The latitude curves show a great difference of phase compared with the other two curves, about 4 years, so that the efficiency of sun-spots in relation to the mean daily range in magnetic declination is greatest when the sun-spots are falling towards the equator. C. P. B.

1161. *Transformations of Special Steels at High Temperatures.* **K. Honda, K. Tawara,** and **H. Takagi** (Tôhuku Univ., Sci. Reports, 5. pp. 135–151, May, 1916.)—In the study of the transformations of special steels at high temperatures, the large displacement of the critical points makes it difficult to correlate them with the A1, A2, and A3 points. Earlier work by two of the authors has shown that considerable light is thrown on the changes occurring in iron and steel by combining magnetic measurements with thermal and micrographic study. Accordingly, six specimens of carbon steels, containing from 0·1 to 1·22 % carbon, and six special steels of the percentage compositions shown in the table below, have been studied magnetically, thermally, and micrographically.

	C	Si	Mn	P	S	Cr	W	Mo	V
A	1·16	2·89	0·21	0·047	0·038	2·74	—	—	—
B	0·66	0·08	0·08	0·018	0·016	3·43	16·81	—	0·11
C	0·64	0·05	0·01	0·015	0·012	3·73	14·06	—	0·11
D	0·82	0·18	0·26	0·003	0·016	3·71	14·63	0·017	0·20
E	0·59	0·22	0·06	0·028	0·023	2·86	18·81	—	—
F	1·05	0·18	0·35	0·009	0·012	—	3·17	—	—

The results show that in plain carbon-steels a magnetic change occurs in the cementite in the vicinity of 200° C. both on heating and cooling. During the eutectic transformation the magnetic properties change abruptly, the magnitude of the change increasing with the amount of eutectic present. A considerable amount of heat is absorbed or evolved during the eutectic change, and the eutectic point on heating is from 30 deg. to 80 deg. higher than that observed on cooling. In the heating curves of steels A, B, and C there are only two peaks in the range of temperature up to 900° C. The first peak is due to the magnetic or A2 transformation, and the second to the A3 change. The position of these peaks is independent of the temperatures to which the steels had been previously heated. In the cooling curves the temperature of the beginning of the magnetic change is practically the same as the temperature of its ending in the heating curves, or, in other words, the critical point remains unaltered in the heating and cooling processes. The A3 transformation, however, is displaced towards a lower temperature which coincides with the magnetic change-point in the second steel, and takes place at a little above the critical point in the first and third steels. The heating curves of D and E steels show two peaks corresponding to the A2 and the A3 transformations; their positions are independent of the max. temperatures previously attained on heating. In the cooling curves the A3 point is lowered until it coincides with the A2 transformation. The amount of displacement increases with the max. temperature of heating. On cooling from 1000° the transformation is lowered to about 400° C. The magnetic tests confirm these results. Steel F shows the magnetic change-point of plain cementite at about 200° C., both on heating and cooling. Both the thermal and magnetic curves show the existence of the eutectic transition-point.

All these results were confirmed by micrographic analysis of the steels after various heat treatments. F. C. A. H. L.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1162. *Technique of the Coolidge Tube.* **A. Teillard.** (Archives d'El. Médicale, 24. pp. 234–243, Aug., 1916.)—The special apparatus for use with the Coolidge tube is described, and a diagram of the connections is given. It is claimed that radiographs can be obtained when the tube is about 9/5 times farther removed from the plate than with ordinary Röntgen tubes, while in practice the fixed focus of emission of the Coolidge tube largely compensates for the greater distance. On this account the danger to the patient is very much reduced. A distance of 90 cm. between antikathode and plate is considered normal. For radioscopic work the usual distance employed is 80 cm. A photometric study of the practical output of the Coolidge tube in function of the intensity is made and compared with an ordinary tube. The general conclusion arrived at is that it is possible to do anything with this tube that can be done with the ordinary type, and to do it more quickly and easily, while for quite a number of special cases it offers very great advantages. A. E. G.

1163. *Electro-vibrators with Small Currents. Electro-vibrators with Resonance.* **J. Bergonié.** (Comptes Rendus, 163. pp. 5–6, July 3, 1916.)—To counteract the effect of the self-induction a condenser is now included in the circuit. An electro-vibrator so employed, when run with a 42-∿ alternating current at 110 volts, takes 7·5 amps., and has a magnetic action equal to the ordinary vibrator without additional capacity run with a current of more than 100 amps. A still more important thing from the practical point of view is that by this new method the vibrator can be used with a continuous current by the aid of a mercury interrupter. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1164. *Influence of Foreign Substances on the Sorption of Uranium X_1 by Charcoal.* **H. Freundlich** and **H. Kaempfer.** (Zeits. Phys. Chem. 90. pp. 681–716, Dec. 28, 1915.)—A fuller account of researches noticed in Abs. 460 (1915). Ritzel [Abs. 460 (1910)] observed in 1909 that carbon (charred blood) "took up"—the authors consider this a special kind of adsorption—uranium X_1 from solution, but that the presence of thorium and of thorium emanation prevented this sorption, which seemed to be a special kind of radio-active effect. Soddy (J. Chem. Soc. Trans. p. 88, 1911), ascribed this peculiarity to the isotopy of Th and UrX_1. The experiments of the authors are a repetition and extension of those of Ritzel whom they confirm on the whole. Experiments were made with uranyl nitrate, thorium nitrate and sulphate, zirconium oxychloride, strychnine nitrate, benzoic acid, basic dyes, and aluminium sulphate. All these, except the Al salt, inhibited or diminished the sorption of the UrX_1 by charcoal or reversed it when subsequently added to the solution which was shaken for periods up to 216 hours. Freshly-prepared UrX_1 was more strongly taken up than solution of long standing, probably because uranyl nitrate and also thorium salts contain small quantities of some still undiscovered radio-elements, which are, however, completely adsorbed when shaken with charcoal. Of the substances chiefly studied (thorium salts, benzoic acid, strychnine nitrate, zirconium oxychloride) only thorium caused an actual reversal, *i.e.* it drove the UrX_1 already taken up again into solution; for this the following explanation is suggested. The UrX_1 is not only concentrated on the surface, but also diffuses into the interior of the charcoal; thorium and the unknown radio-elements mentioned behave similarly. These substances are therefore able to replace the UrX_1 in the charcoal, as (in the experiments of Schulze) the Ag-ion replaces the Na-ion. The other salts may be adsorbed on subsequent addition to the solution and may replace UrX_1, but this action is confined to the small amount of UrX_1 on the surface. Isotopy would, therefore, not explain the reversal or replacement, but the experiments do not disprove the isotopy of the two substances. According to Ritzel ThEm behaved like thorium nitrate as to the reversal; when the authors filtered the emanation through a plug of cotton-wool, however, before adding it to the solution, the effect was not observed, and the authors suggest that the effect was due to dust of thorium nitrate carried over by the emanation. H. B.

1165. *Viscosity of Liquefied Gases.* IV. *Apparatus and Method.* V. *Preliminary Measurements on Liquid Oxygen-Nitrogen Mixtures.* **J. E. Verschaffelt** and **C. Nicaise.** (K. Akad. Amsterdam, Proc. 18. No. 10. pp. 1659–1675, 1916. Comm. No. 149*b* from the Phys. Lab., Leiden.)—The three preceding communications [see Abs. 151, 152, 516 (1916)] contain the development of the theory of the rotational oscillations of a sphere in a viscous liquid. A detailed description is now given of the apparatus designed for measuring the viscosity of liquefied gases at low temperatures; the preliminary results obtained with liquid air and three other mixtures obtained from air—one being almost pure oxygen and the other consisting chiefly of nitrogen—are also given. These mixtures contain argon, and as the measurements are to be repeated with pure substances, the results now communicated are not discussed. T. H. P.

1166. *On the Isotopes of all the Chemical Elements.* **A. van den Broek.** (Phys. Zeits. 17. pp. 260–262, June 15, 1916.)—Considering the number of α-particles emitted in the cases of the thorium and actinium series, it is observed that for six successive elements there is a difference of atomic weight of 16 (corresponding to the emission of four α-particles and two β-particles). Using this property as basis, the author arranges all the elements in a similar manner, and the order suggests that certain series of elements are "isotopes" of one another. A. B. W.

1167. *Position of Martensite in the Iron-Carbon Diagram.* **W. Broniewski.** (Comptes Rendus, 162. pp. 917–919, June 18, 1916.)—Although its marked crystalline structure points to its being a well-defined body stable within a certain interval of temperature, martensite is only regarded as a transition product, and as such finds no place in the constitution diagram of the iron-carbon series. In order to study the conditions of equilibrium of this material comparative tests of the e.m.f.'s of hardened and annealed steels of various carbon contents have been made against kathodes of graphitic carbon and extra-soft steel in an electrolyte of ferrous sulphate solution. The results show that martensite diminishes the free energy of the ferrite in which the carbon is dissolved. By means of the Helmholtz equation it has been calculated that the magnitude of the diminution, is of the order of 16 gm. cals. per 100 of carbon dissolved in 1 gm. of iron. Martensite is to be regarded as a solid solution of carbon (or cementite) in α-iron and whose region of stability is at a lower temperature than that of annealed steel. The limiting concentration, which is below 0·05 % carbon at the ordinary temperature, increases rapidly as the temperature falls, in accordance with a diagram included in the paper. It is probable that martensite obtained by quenching only becomes stable at about the temperature of liquid air, a point which is confirmed by the tendency for austenite to revert to martensite when quenched in liquid air. According to the law of Bancroft and Ostwald, in all chemical phenomena there is an initial tendency to produce, not the most stable condition, but the one which is the nearest approximation to it. Martensite, therefore, is defined as a solid solution of carbon in α-iron, which is stable only at low temperatures, but usually appears in an unstable state of equilibrium as the form which is the nearest neighbour of austenite. F. C. A. H. L.

1168. *The Theory of the Corrosion of Steel.* **L. Aitchison.** (Iron and Steel Inst., J. 93. pp. 77–91; Disc. and Corres., 92–101, 1916. Engineering, 101. pp. 461–463, May 12, 1916. Met. and Chem. Eng. 15. pp. 88–92, July 15, 1916.)—In recent years an enormous amount of work has been carried out on the corrosion of pure iron; the question of the corrosion of steel has, however, received little attention. The problem as regards steel can be attacked on entirely different lines from those used in considering the corrosion of the more simple body, iron. The complex nature of steel renders it almost certain that the action of a corrosive liquid will be mainly galvanic. One of the two constituents will be anodic and the other kathodic, and the extent of the galvanic action will depend upon the difference of potential set up between the two constituents. The author considers the results described in Abs. 824 and 512B (1916), and comes to the following conclusions with regard to the corrosion of steels generally:—The corrosion of a steel takes place simply as a result of action on the ferrite or solid solution. Action upon pure ferrite may be due to p.d.'s between different grains and also to the different solution pressure of the intergranular cement. The e.m.f. of the solid solution with respect to the corroding liquid, is the deciding factor in the corrosion of a steel. Before a third element produces any beneficial effect upon the corrosion it must be added in sufficient quantities to leave a fairly high percentage in the solid solution. Pearlite does not corrode as a whole, the disappearance of the cementite being due entirely to mechanical action. Carbides are not decomposed by ordinary corrosive agents; they merely act as kathodes to the anode of the ferrite or solid solution. F. C. A. H. L.

1169. *Comparisons between Electrolytic and Two Varieties of Arsenical Lake Copper with Respect to Strength and Ductility in Cold-worked and Annealed Test Strips.* **C. H. Mathewson** and **E. M. Thalheimer.** (Am. Inst. Mining Eng., Bull. No. 115. pp. 1185–1218, July, 1916.)—Samples of the compositions given in the table below were procured and subjected to a series of eight reductions from 0 to 70 % for the production of cold-rolled metal. A further series was prepared by subjecting the metals, cold-rolled to a 50 % reduction, to a series of 15 annealings at temperatures ranging from 100° to 1000° C.

	O %.	As %.	Ag %.
Electrolytic copper	0·071	nil	0·0005
Mohawk copper...............	0·052	0·096	0·069
Copper range copper	0·055	0·296	0·051

The two latter varieties contained, in addition, the usual impurities incidental to commercial furnace-refined copper. Each sample was submitted to the ordinary tensile tests and also to microscopic examination. The results, which are summed up in tables and diagrams, show that the tests failed to develop any very striking differences of rolling temper between the different brands of copper used. In ductility as measured by the elongation, the high arsenical copper appeared to decrease more rapidly than the electrolytic copper but only in the early stages of the reduction by rolling. In the samples annealed in an oxidising atmosphere, the high arsenical metal lagged about 50 deg. C. behind the electrolytic copper. Complete softening took place at about 850° in each case, and the proper annealing temperature for electrolytic copper (dull red) produced equally satisfactory results with the other two. Only minor differences in strength throughout the entire annealing range of 400° to 1000° were observed, but the high arsenical product consistently showed the highest values of elongation and reduction of area, and the electrolytic copper had the lowest values. After annealing in an atmosphere of coal gas at 600° only the high arsenical copper showed a fair retention of ductility. At higher temperatures all the samples revealed brittleness and were almost entirely devoid of ductility. Determination of the oxygen contents of the treated samples indicated that partial deoxidation had set in at 600° and was practically completed at temperatures above 800°. Microscopic examination pointed to the superiority of the high arsenical material in the annealed state. F. C. A. H. L.

1170. *The Alloys of Cerium. I. Copper-Cerium Alloys and their Constitution.* **F. Hanaman.** (Int. Zeits. Metallog. 7. p. 174, 1915. Rev. de Mét. 12E. pp. 471–473, Dec., 1915.)—An equilibrium diagram of the Cu-Ce series has been drawn up based on a thermal and microscopic study of the alloys. These two metals are completely soluble in the liquid state, but show very little tendency towards the formation of solid solutions. The diagram shows three minima corresponding to the deposition of eutectics and two maxima corresponding to the crystallisation of the compounds Cu_6Ce, and Cu_2Ce, while the compounds Cu_4Ce and CuCe are formed by reactions occurring between the other two compounds and the residual melt. Determination of the Brinell hardnesses of the alloys showed maxima corresponding to the compositions of Cu_6Ce and Cu_2Ce. Only the alloys containing between 55 and 85 % Ce were found to be pyrophoric, but the property is nothing like so pronounced as it is in the Fe-Ce alloys. Contrary to previous observations, the metallic cerium (97 %) used by the author was not found to be pyrophoric. F. C. A. H. L.

1171. *Binary Alloys of Aluminium.* **H. Schirmeister.** (Stahl und Eisen, 35. pp. 648, 873, and 996, 1915. Rev. de Mét. 12E. pp. 464–470, Dec., 1915.)—The author has studied the effects of technical importance, of the addition of twenty metals to commercial aluminium. Examination of the diagrams summing up the results indicates that the greatest technical improvements of Al are effected by alloying with Zn, which can be added up to 25 % without destroying the working qualities of the metal. These alloys, particularly those rich in Zn, do not resist the effects of atmospheric corrosion. Next in importance are the alloys with Cu and Mg. Magnesium can be added in quantities up to 12 %, but difficulty in rolling is experienced when the content exceeds 6 %, which composition is also that of the alloy with the best rolling properties. For castings the best Al-Cu alloys are those containing from 10 to 15 % Cu, while the best castings are obtained from alloys containing 3 to 4 % Cu. The copper alloys resist atmospheric corrosion well. Of the rare metals only chromium exerts a well-marked beneficial influence. The quantities in which it may be added are up to 5 % for rolling and from 1 to 3 % for castings. F. C. A. H. L.

1172. *Ebullioscopic Behaviour of Solvents at Different Pressures.* **E. Beckmann** and **O. Liesche.** (Zeits. Phys. Chem. 90. pp. 129–138, Aug. 27, 1915.)—Addendum to previous papers and reply to Jellinek [Ibid. 88. pp. 13, 23, and 419, and 89. p. 111] with regard to sources of error. Beckmann recognised in 1889 that the introduction of solute raises the height of the liquid column and thus the mean boiling-point; this is insignificant at ordinary pressure—at which an additional height of 1 mm. of ethyl ether would raise the boiling-point by 0·002 deg.—but not at reduced pressures. A. Smits found later that the error cannot simply be corrected by a formula, and that the error amounts, for 1 cm. of water, only to one-third of its assumed value. The impracticability of a theoretical correction is confirmed, and it is also shown, by experiments with ether and aniline, that the rise of the liquid column cannot be compensated for by withdrawing the themometer. The further remarks concern the automatic pressure regulation in the author's manostat, in which over the pressure range of 100 and 200 mm. constant pressure can easily be maintained within 0·01 mm. for 20 minutes and within 0·1 mm. for hours; that corresponds to temperature constancy within 0·001 and 0·01 deg. [See also Abs. 629 (1916).] H. B.

1173. *Transition-points of Nitrates (Silver, Ammonium, Potassium).* **E. Jänecke.** (Zeits. Phys. Chem. 90. pp. 280–295, Sept. 24, 1915.)—The results of the experiments with the electrically-heated press [see Abs. 1135 (1916)] confirm previous observations. In the case of KNO_3 a new transition-point is found, at about 151°, so that three varieties of this nitrate seem to exist. The transition may be marked by a sudden or gradual change in the curve; in the latter case the intersections of the produced rectilinear graphs were taken as transition-points. Readings were generally taken at intervals of half a minute, both on heating and cooling. *Transition Phenomena of Isomorphous Mixtures of KCl-NaCl, AgCl-NaCl; Complete Diagrams of Conditions* (Ibid. 90. pp. 296–312). Some binary isomorphous mixtures show a minimum melting-point at certain proportions of the constituents, and should "unmix," *i.e.* the constituents should crystallise separately, below this temperature. This was known for KCl-NaCl, but the complete diagram of the separation had not so far been obtained. Mixtures of AgCl and NaCl do not exhibit any minimum melting-point, and unmixing had not previously been observed in their case. The author shows that separation takes place and gives the complete diagrams of condition for the two cases. H. B.

1174. *Transition of the Metals Tin, Zinc, Bismuth, Cadmium, Copper, Silver, Lead, and Antimony.* **E. Jänecke.** (Zeits. Phys. Chem. 90. pp. 313–339, Sept. 24, 1915.)—The pressure-temperature graphs, heating and cooling curves [see preceding Abs.], confirm on the whole the observations of Cohen and Helderman; the transition of silver into an allotropic modification at about 120° had been suspected from the thermoelectric studies of silver-nickel couples by v. Hevesy and Wolff [see Abs. 131 (1911)], but had not yet been established. But the author differs from Cohen as to the theory; he prefers to base his arguments on the thermodynamic potential of A. Smits.

H. B.

1175. *Hypothesis as to the Condition of Dissolved Electrolytes.* I. and II. **H. C. S. Snethlage.** (Zeits. Phys. Chem. 90. pp. 1–46, June 15, and pp. 139–188, Aug. 27, 1915.)—From a critical examination, partly based on new experiments, of the properties and behaviours of electrolytes, including reaction velocity, catalytic action, light absorption, determination of molecular weights, etc., the author arrives at the conclusion that the theory of Arrhenius—that the molecule of an electrolyte in solution partly splits into ions which are independent of one another, and that the degree of dissociation changes with the concentration—must be abandoned. The author did not start with this presumption. He had believed (with Arrhenius and H. Goldschmidt) that although the non-dissociated molecules also would act catalytically it was yet possible to calculate the catalytic efficiency from the electric conductivity. The dissociation theory does not assert anything as regards the cause of the catalytic action, but it tacitly assumes that there is a connection between the electric charge of the $H^{\cdot}$-ion and its catalytic effect. This, however, is incompatible with the hypothesis that the quotient k_M/k_H is a function of the strength of the acid catalyst in the sense that the stronger the acid the greater this quotient; k_M being the velocity constant due to the undissociated molecules, and k_H the same due to the $H^{\cdot}$-ions.

Part I deals with solutions of electrolytes in alcohols (ethyl and methyl). As to these solvents two groups of electrolytes must be distinguished: (1) Strong electrolytes (hydrochloric acid, salts) whose properties (including change of conductivity with dilution by water, but with the possible exception of boiling-point) are proportional to the total concentration of the electrolyte or to some simple function of it; the Δ_v/Δ_∞ is meaningless in this case. (2) Most organic acid and bases, for which this simple proportionality does not hold, the activity increasing with decreasing concentration. The behaviour of electrolytes of the second group does not depend upon the presence of free ions, but upon some definite property such as a polarity or activity of the dissolved molecules. The molecules of the first group are all in this active condition—excepting throughout these considerations too high concentrations; in the second group an equilibrium exists between active and inactive molecules, the equilibrium being approximately given by Δ_v/Δ_∞. The dissociation constant is highly influenced by the solvent, and the change in equivalent conductivity is in the second group due to the transition of inactive into active molecules. The molecule becomes bipolar by the introduction of an electron, to which it owes its properties, including probably affinity, without any real splitting into free ions; hence also the catalytic effect of salts like acids. If the active molecule be regarded as solvated, then the transition can be represented by: inactive molecule + solvent $\longrightarrow$ solvated active molecule.

Part II carries these arguments further with respect to aqueous solutions. There again two groups of electrolytes must be distinguished. The first group comprises strong electrolytes, such as KCl, HNO_3, NaOH. Many of the most important properties of these are independent of the concentrations calculated in mols; but this independence does not hold for the conductivity of all the electrolytes and not for the lowering of the freezing-points of salts. The quantitative variation of these properties with concentration is best understood on the assumption that the degree of dissociation does not change. The proportionality between effect and concentration becomes apparent only, of course, below certain limits of concentration, and these limits are not the same in the case of the same electrolyte for different properties (inversion of sugar, freezing-point), and are, further, different for the same property in the case of different electrolytes. These electrolytes seem to exert their properties through the entire molecules; that would not contradict the assumption of an additive character of most of, and possibly all the properties. The solutions behave as if all the molecules were in the same condition at all (except too high) concentrations. The mass law has no significance for these electrolytes. Differences observed in the behaviour of electrolytes with a common ion are due to the non-common ion, and these differences follow the order of the potential series. The activity (electrolytic and catalytic) may decrease or increase (for acids and bases) with the concentration; it might be calculated by the cube-root formula according to which the change in molecular activity is proportional to the mean distance between the dissolved particles ($a\sqrt[3]{c}$), where c indicates the total concentration (Noyes and Falk). In explanation three assumptions might be made: (1) the strong electrolytes have all the same degree of dissociation, independent of concentration; (2) they are not dissociated at all, all the molecules being active; (3) their dissociation degree lies between 0 and 1, but is independent of concentration. Of these (3) is highly improbable; the discrimination between (1) and (2) is difficult. The osmotic pressure phenomena favour (1); but the author showed in Part I that strong electrolytes conduct and act catalytically in alcohol and in water, and it would appear that the osmotic phenomena are not so simply related to dissociation as had been supposed, but are due to some unknown property of the electrolyte-molecule which is particularly strong in water. The author does not wish to imply that the existence of a dissociation in the sense of Clausius and Williamson must be excluded; dissociation might be understood as Pickering indicated in 1891. The activity is finally attributed by the author to an irregular distribution of electrons in the molecule. In the case of binary electrolytes an electron has a definite position in the molecule to which it imparts polarity and activity, and the polar forces determine its properties.

As regards the second group of electrolytes (most organic acids and probably bases, ammonia, sulphuric acid) they consist of two types of molecules, differing in degree only, the one type active (like those of the first group), the other less active, "preactive," not yet preformed. To the latter the law of mass-action is applicable. Instead of dissociation the author here suggests activation. There is equilibrium between the two types shifting with the concentration, and a gradual change; the strongest electrolytes of the second group do not differ much from those of the first group. The relationship between the two groups would resemble that of a saturated gas below the critical temperature to the same gas above the critical temperature.

In a third paper the influence of the solvent is further to be discussed. An addition to Paper I at the end of II gives some new tables of electric conductivity (picric acid, etc.) after H. Goldschmidt. H. B.

1176. *New Form and Principle of the Dilution Law of Electrolytes.* **G. v. Georgievics.** (Zeits. Phys. Chem. 90. pp. 340–358, Sept. 24, 1915.)—The author starts from the formula $c_i^n/c_s = k$, where c_i is the concentration of the dissociated portion, c_s that of the not-dissociated portion, and k a constant. Ostwald assumed $n = 2$ for aqueous solutions of binary compounds, van't Hoff 1·5, Storch found n simply, but n differing for different electrolytes. To find the relation of n to other properties, the author made the following assumption. If $n = 1$, then the quotient $= k$ would be represented by a straight line as resultant of two forces, one of which tends to keep the components of an electrolyte together, while the other tends to split them. If there were a third force, then n should be greater than 1, and as a matter of fact n is found greater than 1, but approaches 1 for acids and bases with increasing dilutions. The variability of n in these cases could only be explained by adsorption and attraction between the ions. If differences of principle do not exist in the dissociation phenomena of acids and bases on the one hand, and of salts on the other, then the simple law $c_i/c_s = k$, should hold also for salts. Examining the data of various experimenters concerning a great number of acids, bases, and salts, the author finds, however, that the n values for salts differ from those for bases and acids. There should be a relationship between internal friction and migration velocity of the ion on the one hand and n on the other, a relationship due to chemical affinity between the water and the electrolyte. This relationship does not suffice, however, to explain the different n values, which are found to be independent of the number of ions, so that the law of mass-action does not hold for aqueous solutions of all electrolytes. There is parallelity between the chemical affinity for water and n for acids and bases, but not for salts, in which complications take place. The author further shows that the partition of a substance between two phases can be expressed by an analogous formula $c_1^n/c_2 = k$, in which n is also 1 when no complications arise. H. B.

1177. *Demonstration of the Rational Character of the New Solubility Formulæ.* **A. Colson.** (Comptes Rendus, 163. pp. 57–59, July 17, 1916.)—A mathematical demonstration that the principles of thermodynamics are applicable to solutions. [See Abs. 1092 (1916).] A. F.

1178. *Electrostatic Measurements of Electrode Potentials.* **G. Borelius.** (Phys. Rev. 8. pp. 128–132, Aug., 1916.)—The author gives a critical comparison of the methods used by Ewell [Abs. 513 (1915)] and himself [Abs. 1171 (1914), 513 (1915)] for the measurement of electrode potentials by electrostatic methods. The two different methods are shown to be practically equivalent to each other, but the present author criticises the interpretation which has hitherto been given of the results. He comes to the conclusion that hitherto the electrostatic measurements on electrode potentials have given no proof which can be used as evidence against the usual theory of their absolute values. T. S. P.

1179. *Electro-analytical Method for Estimation and Separation of Metals of the Copper-Tin Group.* **E. P. Schoch** and **D. J. Brown** [with **T. E. Phipps**]. (Am. Chem. Soc., J. 38. pp. 1660–1681, Sept., 1916.)—An account is given of the methods elaborated by the authors for the estimation and separation of the metals of the copper-tin group, using an electrolyte containing the chlorides of the various metals. In order to prevent the oxidising action of the chlorine liberated at the anode, certain reducing agents are added to the electrolyte, the most suitable being hydroxylamine hydrochloride. The electrolyte is thoroughly stirred by a rapidly revolving glass stirrer during the analyses, and the method of graded potential, using an auxiliary electrode, is made use of [compare Sand, Abs. 932 (1907)]. Details are given of the following operations, all of which can be carried out with satisfactory results :—Estimation of Sn. Modification of Classen's ammonium oxalate method for the estimation of Sn. Estimation of Cu. Separation of Cu from Sn. Estimation of Bi. Estimation of Sb. Separation of Sb (or Bi) from Sn. Estimation of Pb. Simultaneous deposition of Pb and Sn and their separation. Separation of Sn from Cd. Separation of Cu from Sb by means of hydrochloric-tartaric acid electrolytes. Separation of Cu and Sb from Pb. Separation of Cu from Sb by means of nitric-tartaric acid electrolytes. Simultaneous deposition of Sb, Bi and Cu out of electrolytes containing these metals and Sn. Simultaneous deposition of Cu, Bi and Sb out of electrolytes containing these and also Pb and Sn. Separation of Bi from Sb. Separation of Cu and Bi from Sb. T. S. P.